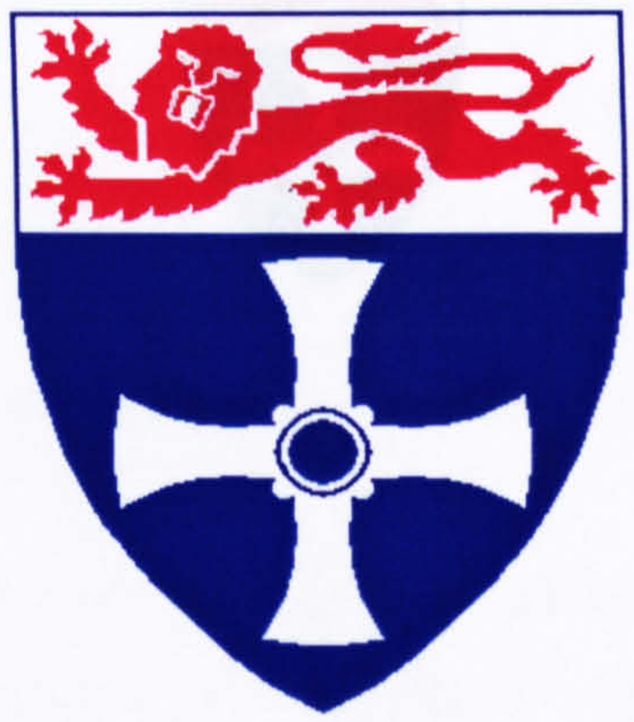

'THINKING ABOUT PEDAGOGY'

AN INVESTIGATION INTO THE IMPACT OF THE TEACHING OF THINKING ON TEACHERS' PEDAGOGY AND IMPLICATIONS FOR PROFESSIONAL DEVELOPMENT

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DECLARATION

I certify that all the material submitted in this work which is not my own work has been identified and that no material is included which has been submitted for any other award or qualification.

Signed:

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Dated:

06/10/03.....

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ABSTRACT

The study aimed to determine the extent to which a thinking skills programme influenced the beliefs and practices of secondary teachers in the Dominican context. The study further intended to assess the degree to which the teaching of thinking influenced teachers' professional development, particularly their ability to reflect on practice.

Mathematics teachers of three secondary schools were observed and interviewed in an effort to record patterns of change in beliefs and practices. In addition, the teachers were asked to keep journals to aid their reflection on practice. The data collection was divided into three components, namely data gathered at *pre-intervention, intervention* and *post-intervention* phases. The purpose was to assess potential changes in teachers' perceptions and behaviours during and after the active intervention period. Both qualitative and quantitative methods were used for the analysis of research findings.

The findings revealed irrespective of school status and the availability of human and financial resources, there was no obvious difference between schools relating to changes in teachers' beliefs and practices. In many cases there was greater variation among teachers within the same school, than there was among teachers of different schools. The study further revealed all teachers appeared to have an external locus of control as reflected from their reasons for lack of sustained changes in practice. Trained teachers blamed the Education System (curriculum framework, assessment system, unavailability of resources, time constraints, etc) for their limitations, whereas untrained teachers blamed lack of training. It was concluded that teachers would only subscribe to long-term change in practice if they believe such change would not add to existing pressures, even if there were potential benefits to students.

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Acronyms

BERP: Basic Education Reform Project

CAME: Cognitive Acceleration in Mathematics Education

CEE: Common Entrance Examination

CSE: Comprehensive Secondary Education

CXC: Caribbean Examination Council

EDP: Education Development Plan

ERU: Education Research Unit

EQMU: Education Quality Monitoring Unit

MOE: Ministry of Education

SYMBOLS

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CHAPTER 1

ESTABLISHING THE CASE FOR THE STUDY

1.0: Introduction

The teaching of thinking is viewed as a catalyst for efficiently accessing school curricula. It is grounded on the belief that schools *must* prepare students for a competitive and ever-changing world. The pace at which information changes and the current volume of available information means that students need not only be given knowledge but must also be taught the appropriate skills to aid in the acquisition and effectively utilisation of whatever information exist in the future.

According to Costa (1991), if education is to achieve an intellectual focus, then the total school environment must mediate all its inhabitants' intellectual behaviour. Mediation must consider not only changes in the content of knowledge and skills but also the pace at which these changes occur. In order to aid in the efficiency of student learning, the teaching community must uphold the development of autonomy in students. Mc Guinness (1999) argued that the development of thinking skills in students requires teachers to maintain an open-minded attitude about the nature of knowledge and thinking and to create an educational atmosphere where metacognition, predicting, questioning, contradicting and doubting are actively pursued.

There is a mutual relationship between the teaching of thinking and the professional development of teachers since teachers may utilise the teaching of thinking as a trigger for improvement of practice. As stated by Adhami et al. (1997), there is a link between students'

mode of work during thinking lessons and the professional development of teachers, since the teaching of thinking assists in reflection, which consequently leads to improvement in teachers' professional practices. Hence, with reflection on practice teachers expose their successes and limitations, subjecting their practice to scrutiny and subsequent improvement. Costa (1992) conceded that as teachers teach students to think, they become more aware of the conditions that promote students' thinking and become more powerful thinkers themselves, further enhancing their professional development.

Teachers' perceptions are just as essential as their practices since perceptions guide and inform practice. Therefore, efforts to improve practice would only be realised if teachers uphold the belief that practice can be improved. Hence, the ultimate goal of increased learning in students can only be achieved if teachers constantly strive to enhance their classroom performance to the point where effective instruction and real learning becomes the norm.

1.1: Organisation of the text

This study comprises six Chapters. *Chapter one* provides an outline of the study. It establishes the purpose and aims, provides an overview of the educational context of Dominica and a statement of the educational concerns. The chapter concludes with the main research question and sub questions.

Chapter two explores a review of pertinent literature. The chapter addresses the issue of teachers' beliefs and practices. It explores potential influences of teachers' beliefs on their classroom practices and provides a critical analysis of the arguments for and against such influences. In addition, the issue of professional development and teacher education is explored. The chapter gives an account of arguments for and against reflection on practice, as well as the aims of teacher reflection. The issue of organisational culture is addressed along with the relationship between school culture and receptivity to innovation. Further, various theories of learning are discussed as well as their implications for classroom practice. The chapter also considers issues relating to the teaching and learning of Mathematics. The chapter concludes with a discussion of issues relating to the development of thinking skills in students. More specifically, it addresses the effectiveness of Cognitive Acceleration in mathematics Education (CAME), which is a thinking skills approach infused in the context of mathematics education.

Chapter three establishes the methods for implementation of the practical research activity. It includes the framework for the study, various methodological aspects and a critical exploration of the researcher's epistemological base. In addition, arguments for and against qualitative and

quantitative methods are discussed. Further, the chapter reflects on ethical concerns and their impact on the study. The chapter ends with a detailed exploration of the practical research activity as well as methods used to enhance the reliability and objectivity of the study.

Chapter four comprises the presentation and interpretation of research findings as well as research conclusions. This chapter is divided into four sections. Data presentation in the first three sections represents information gathered from the three schools under study. Each school is considered a separate case. Within these sections, individual from the schools are considered smaller cases nested within each major case (each school). The fourth and final section of chapter four represents an analysis among the three schools under study.

Chapter five includes a discussion of the findings and their relevance to other research studies. The chapter also considers the implications of findings for the education system in Dominica.

Finally, *chapter six* comprises general conclusions and a series of recommendations for the enhancement of education in Dominica, as well as recommendations for further study.

1.2: Purpose of the research study

The study involved the implementation of a cognitive intervention programme [*Cognitive Acceleration in Mathematics Education* (***CAME***)] at three secondary schools in Dominica in order to determine:

- *The extent to which it contributed to the professional development of teachers as it relates to their ability to reflect on practice.*

- *The degree of change in teachers' beliefs and/or practices as a result of the innovation.*

1.3: Aims of the research study

The main aims of the study were to:

- *Foster an ethos of continuous professional growth among secondary teachers through reflection and subsequent improvement of practice.*

- *Improve students' cognition through a teaching approach that would solicit a greater degree of classroom interaction and cognitive challenges.*

- *Establish and maintain a network of focussed collaboration among the staff of the schools involved in the research.*

1.4: Personal motives

In addition to emphasising the need for enhancing teachers' professional practice and consequently school efficiency in the Dominican context, there were also personal motives for undertaking a study of this nature. Firstly, there was a burning desire to conduct in-depth research on teachers' professionalism in the Dominican context as it related to reflection and subsequent improvement of practice. This desire was triggered by the researcher's experience as a schoolteacher and subsequently as an in-service teacher trainer in Dominica.

In addition, the development of thinking skills in students has been an area of interest and having completed research in this field as part of the requirements for a Master of Education award, it was felt that a study of greater depth would give the researcher a profound knowledge

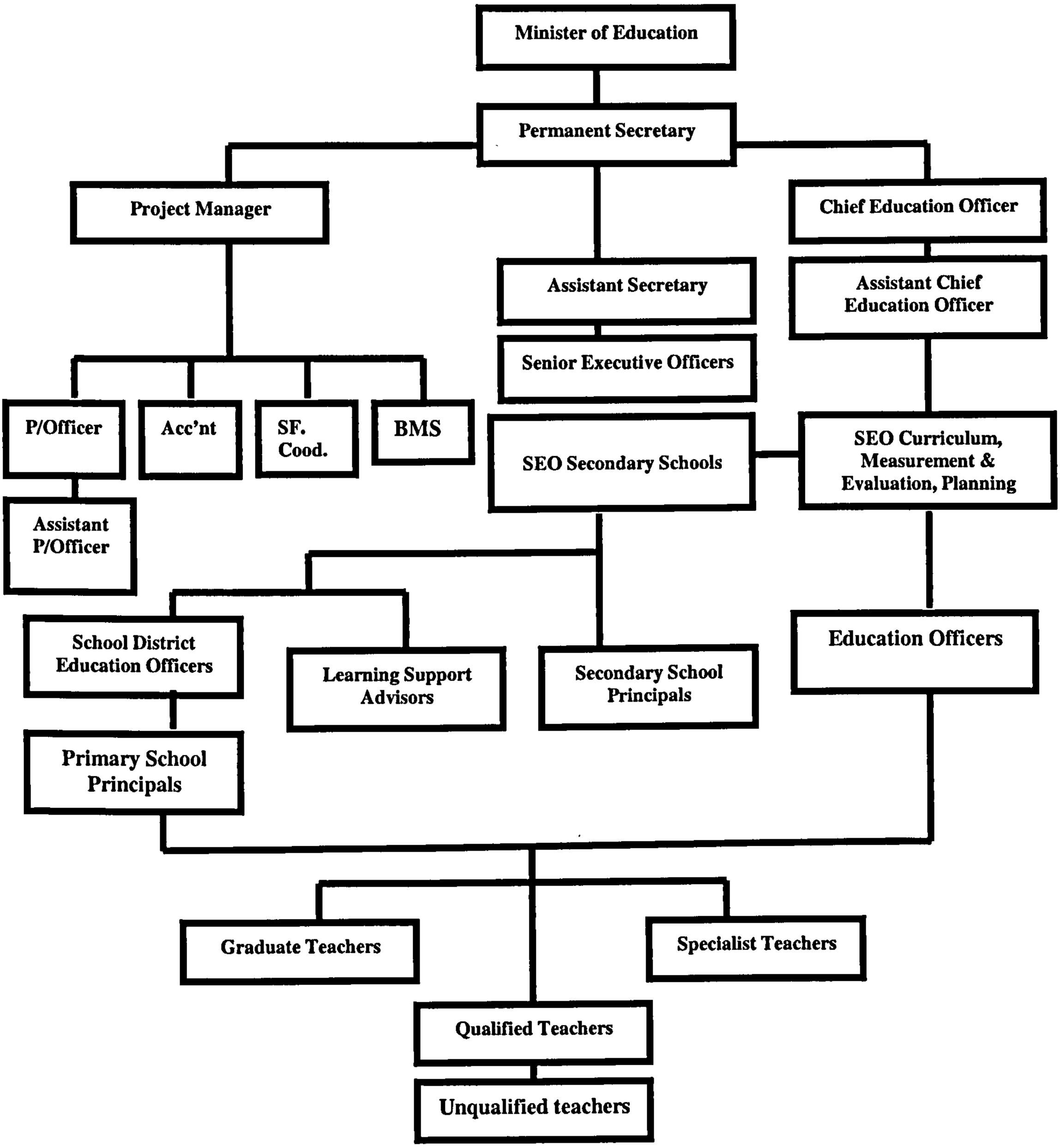
of ways through which thinking skills programmes could be used to enhance teaching and learning in the Dominican context.

It would be unfair not to mention the researcher's desire to obtain some form of recognition from this study. It is hoped that this recognition would be in the form of a formal authorisation to continue further research through receipt of a PhD award.

1.5: The context of the study

1.5.1: The educational background of Dominica

The Commonwealth of Dominica is a small Caribbean island with a population of just over seventy thousand (70,000) and an area of three hundred square miles. Standard English is the official language spoken on the island. However, there is a French Creole dialect that is widely used among the natives. This dialect is often used in social contexts but is not formally taught in schools. Traditionally, the French Creole dialect has been viewed as a language of the inferior and therefore many parents, particularly those of the upper class, are reluctant to allow their children to openly speak the language. Since the island was colonised by Britain until 1978, the education system still has many similarities with that which existed in Britain in the nineteen seventies. Dominica's education system is highly centralised and as such individuals at the highest level decide on major education initiatives (Fig. 1.0), often leaving implementation to those at the lower levels.



1.0: The organisational structure of the Ministry of Education in Dominica

Key:

P/Officer: Procurement Officer

Accn't: Project Accountant

BMS: Building Maintenance Supervisors

SF Cood.: School Feeding Coordinator

SEO Senior Education Officer

Comprehensive Primary Education is provided for students between the ages of five (5) to eleven (11) years but students are required to write an entrance examination at the age of eleven in order to be selected for secondary school. Students who are successful at the national Common Entrance Examination (CEE) follow a five-year programme of secondary education. Those who are unsuccessful enter the job market, while others may receive a chance to follow a technical vocational education programme. On occasions, students who excel in the technical vocational programme may get another chance at the academic stream of a secondary school where they are placed at Forms two (2) or three (3).

Secondary schools in Dominica are afforded slightly more autonomy than primary institutions in terms of decision-making and staff recruitment, but there is still a high degree of central control. According to Henry (2002), there are disparities among secondary schools in Dominica in terms of staff training and experience, staff student ratios and provisions for students. In recent years, Comprehensive Secondary Education has been advocated through the Basic Education Reform Project (BERP). The Basic Education Reform Project was an elaborate five-year education initiative proposed by the Government of Dominica in 1998/1999 in order to improve education standards through restructuring of the entire education system.

As part of the BERP initiative, a pilot Comprehensive Secondary Education programme was implemented in 1998/1999 with the hopes of a gradual movement towards secondary education for all students on the island. To this day, the pilot programme is still in place and as such a few school districts on the island still practice Comprehensive Secondary Education. The initiative has encountered widespread resistance from teachers. Many teachers argue, the fact

that the initiative does not consider the results of the Common Entrance Examination for secondary education provision, means that the quality of students entering secondary school is well below expected standards both in terms of behaviour and intellectual capabilities. The issue of Comprehensive Secondary Education has also encountered resistance among politicians and policy makers alike. To this end, different political parties have given differing levels of priority to the initiative, contributing to a lack of full implementation to this day.

According to the Education Development Plan (2000-2005), the vision of the Ministry of Education (MOE) is '*high quality education for all*' (*Appendix A*). The Education Development Plan conceded that the *role of the Ministry of Education is changing from one of authority and administration to one of policy-making, investment, management and quality assurance* (pg vii). In addition, the MOE proposed a change of culture from a 'command centre' to a 'service provider', hence repositioning institutional responsibility (Education Development Plan, pg. 2).

The Education Development Plan recognised some of the key priorities for the MOE as:

- *Including a National Curriculum (5-16) and continuing nationwide assessment.*
- *Ensuring universal access to secondary education.*
- *Establishing school boards of management with clearly defined roles and areas of responsibility*
- *Improving professionalism and commitment to the teaching service*
- *Increasing levels of literacy, numeracy, scientific and IT skills for all learners.*
- *Changing the culture and strengthen the capacity of the Ministry of Education, improving the qualification and professional development of staff, strengthening the capacity of institutions through improved management and performance review and repositioning institutional responsibilities.*

(pp. 5 and 6)

Currently, Dominica's education system is in transition and a number of new initiatives have been launched over the past years. According to the *Education Act 1997, Sec 4 (1a)*, one of the goals of the Education system in Dominica is the establishment of a relevant, varied and comprehensive educational system that is characterised by excellence (*Appendix B*). Hence, as its mission, the Ministry of Education undertakes to '*guarantee equitable access to high quality education and training which will develop in all citizens the capacity to lead productive and fulfilling lives in a complex and changing society*' (Goals, Core and Foundation Subjects and Compulsory Curriculum for proposed National Curriculum in Dominica 2001).

One of the latest initiatives of the Ministry of Education is the proposed establishment of a National Curriculum. As cited in the *Education Act (1997; Sec. 137 [1 & 2]*), the Minister shall establish a National Curriculum for public and assisted schools, which must be balanced and broadly based and which should prepare students for opportunities, responsibilities and experiences in adult life (*Appendix B*). This proposed National Curriculum is intended to replace existing school curricula, which varies from school to school. As stated by the National Curriculum Technical and Steering Committees (pg. 8), the rationale for the proposed National Curriculum are to:

- *Lessen differences between schools*
- *Improve communication*
- *Provide continuity in learning*
- *Reduce inequality of provision*
- *Provide a yardstick for assessment*
- *Raise standards*

The National Curriculum initiative sounds convincing since it is in line with the progressive view of education proposed by the Ministry of Education. However, there has been little or no efforts to address the traditional examination frameworks. Over the past several years, local examinations placed much emphasis on *pen-and-paper* tests and these often make limited provision for transfer of information in meaningful ways.

1.6: Nature of the education dilemma in Dominica

Currently, secondary education in Dominica is centred on didactic modes of instruction with an emphasis on traditional assessment approaches. This problem is fuelled partly by the fact that most secondary teachers in Dominica are untrained (*Appendix C*). Hence, many teachers many lack the knowledge of effective instructional methods or of the theories underpinning chosen methods. Although recent government policies in Dominica have advocated the use of progressive approaches to teaching (Education Development Plan 2000-2005), the national assessment framework, traditional classroom settings, inflexible school curricula and the inadequacy of trained teachers seem to deter their efforts.

According to Henry (2002), instruction in Dominica includes programmes that are largely centred on 'chalk-and-talk'. This means that teachers take an active role in the classroom, leaving students as passive participants in the learning process with limited ability to think for themselves. The predominance of traditional teaching approaches has also had an impact on student performance at the secondary level in Dominica. Henry (2002) suggested that there are major problems in terms of student performance in Mathematics and Science during the Caribbean Examination Council (CXC) examinations (*Appendix D*). According to Henry

(2002), there is a high likelihood that the country in under-supplying itself with the numbers needed for entry into occupations requiring a strong Mathematics and Science base. Hence, there seems an obvious need to address this problem at the secondary level. Henry claimed schools' performance in Mathematics leaves much room for improvement and only the traditionally prestigious schools obtain satisfactory performance in the subject.

As stated by Haynes (2002:35), teaching students to think for themselves, to question received knowledge and to learn through challenge, scrutiny and deliberation of ideas, has been at the heart of a view of education that espouses creativity, invention and progress. Such characteristics are rarely observed in secondary schools in Dominica. Further, from constant interaction with teachers in Dominica, it could safely be concluded that many teachers consider teaching as a vocation and hence, do not see themselves as true professionals. Although there has been a degree of progress in the performance of secondary students in Dominica over recent years, much improvement is needed in terms of teaching and learning.

1.7: Problem Statement

Most secondary teachers in Dominica are untrained and as such there is an over-reliance on traditional instructional and assessment methods. In addition, teachers appear unaware of the need for, and methods of, reflecting on practice, resulting in minimal opportunities for their professional growth. The continued use of traditional teaching methods in Dominica has resulted in students lacking the ability to think for themselves, leading to underperformance in some subjects during national and regional examinations (*Appendix D*). Hence, in addition to

obvious need for pre-service teacher training, the following questions necessitate an in-depth inquiry.

1.8: Research question and sub-questions

Research question:

How does the teaching of thinking skills influence beliefs and practices of secondary Mathematics teachers in the Dominican context?

Sub questions:

- *How does the teaching of thinking impact on traditional beliefs and practices?*
- *What is the relationship between teachers' beliefs and practices on teaching of thinking?*
- *How can teacher reflection influence their perceptions and practices?*
- *How does the teaching of thinking impact on staff collaboration?*

CHAPTER 2

THEORETICAL BASE

2.0: Introduction

The research study focussed on two major themes. Firstly, there was a discussion of the impact of teachers' *beliefs on classroom practice.* Secondly, the study explored the importance of *reflection on practice* as it relates to the enhancement of practice. In addition to the main areas stated above, there was a critical discussion of various theories of classroom learning, the development of thinking skills in students, Mathematics learning and the implementation and management of education innovations.

In the educational context, one cannot always divorce beliefs from practice since individuals may sometimes act based on *what they think.* Hence, teachers may demonstrate specific classroom behaviours with genuine reasons for such actions. In the same vein, teachers' perceptions may not always be consistent with their practices since they may have certain convictions but their actions may contradict such convictions. This does not necessarily mean teachers are being untruthful but rather they demonstrate subconscious behaviours until these are brought to light by an unbiased observer.

In the absence of the luxury of having an unbiased observer, the teacher has no choice but to *reflect* on his/her own classroom practices. In the typical classroom there are no adult observers so one can safely say that reflection on practice is an essential component of professional growth. Teachers need to engage in exposing their beliefs and practices to self-

criticism so that they can identify their strengths and limitations, hence taking subsequent action based on their discoveries. Reflection enhances professional growth since improvement of practice is often a consequence of revealing one's limitations.

The above issues established the following three points of interest in the study:

- *The relationship between what teachers say and what they actually do in the classroom*
- *The impact of reflection on professional growth*
- *The extent to which an intervention may influence teachers' beliefs and practices*

These issues are explored in greater detail so the case for teacher reflection, professional growth, beliefs and practice will be rested at this point. It should be noted that the following presentation is only intended as a contribution to the existing debate on the above issues and although it may initially appear elaborate, it should in no means be considered exhaustive.

2.1: The influence of teachers' beliefs on classroom practice

Teachers' classroom practices undoubtedly impact on students' learning. Hence, it is obvious that their values and perceptions pertinent to the acquisition and utilisation of knowledge and skills remain paramount to students' cognitive development and future achievement. The term belief may carry various connotations and at the most basic, it relates to qualities that are not physically evident but may be manifested through one's convictions and actions. Clandinin et al. (1987) argued that in addition to the fact that they are not directly observable, one of the difficulties in examining teachers' beliefs is that there is some disagreement between beliefs and knowledge. Alexander and Dolchy (1995) believed it is unclear where the boundaries of these two concepts lie. However, according to Bennett et al. (1997), there is a growing

tendency to regard these concepts as synonymous or to envelop beliefs within definitions of knowledge.

2.1.1: Definitions of beliefs

Harvey (1986:660) defined belief systems as a set of conceptual representations which signify to its holder a reality or given state of affairs of sufficient validity, truth and/or trustworthiness to warrant reliance upon it as a guide to personal thought and action. Gentner and Gentner (1983), provided a slightly ambiguous definition in their consideration of belief systems as mental models or integrated systems of concepts, scripts and scenes that lend meaning to action. Clarke (1988:5) interpreted belief systems as implicit theories or 'eclectic aggregations of cause and effect propositions from many sources, rules of thumb, generalisations drawn from personal experience, values, biases and prejudices'. Irrespective of the definition preferred, the following central question is still unanswered. Hence, one may ask; *is there a direct relationship between teachers' beliefs and their classroom practices?*

2.1.2: Can teachers' beliefs influence classroom practice?

According to Bandura (1986) the beliefs that teachers hold are the best indicators of the decisions that they make during the course of everyday life. Tabachnick and Zeichner (1984) suggested that belief systems serve as a basis for subsequent action. Rueda and Garcia (1994) added that it is unavoidable that belief systems, like all cognitive processes, must be inferred from behaviour. They believed it is important to explore beliefs not only in publicly declared general propositions, but also in terms of more private and unrecognisable situations. As stated by Feiman-Nemsen and Floden (1986:508), teachers' cultures are embodied in the work that

they share. Richard and Lockhart (1994) suggested these beliefs come from many sources including:

- *Teachers' own experiences as learners.*
- *Experiences of what works best.*
- *Established practice.*
- *Personality factors.*
- *Educationally or research-based principles.*
- *Principles derived from a specific approach or method.*

Thompson (1984) argued if it can be assumed that teachers' behaviour is rational, then it is reasonable to assume also that their conceptions of the subject matter and its teaching will have some bearing on their action. Orton (1996) added that teachers' beliefs are related to student learning through some event or sequence of events, mediated by the teacher, which happens in the classroom. According to Rueda and Garcia (1994), beliefs teachers hold impact on both their perceptions and judgements and subsequently affect their behaviour in the classroom. Dunne (1993) held the view that the bulk of teachers' beliefs about teaching relates specifically to classroom practice and may develop only in the context of classroom teaching. Further, Clarke and Peterson (1986:287) asserted that teachers' behaviours are guided by, and make sense in relation to personally held systems of beliefs, values and principles. Put succinctly, the authors above argue that teachers' beliefs do influence classroom practice.

According to Orton (1996), often teachers make the transition from beliefs to action without conscious awareness. He believed teacher competence is regarded as unconscious in the sense that the primary feature of interest is the product and not the cognitive activity of the teacher that gives rise to the product. It may be argued, however, that unconscious competence may not always serve as the rationale for teachers actions since most often teachers' classroom

actions are carefully orchestrated based on their perceptions of student learning. (See Askew et al.1997). A summary of the *Effective Teachers of Numeracy Final report* (Askew et al. 1997:18) revealed that teachers beliefs are shaped by two complementary aspects namely, their classroom practices and secondly the understanding that they possess, referred to as pedagogic content knowledge. They claimed that teachers' beliefs are at times implicit and tend to shape rather than control behaviour. The report categorised teachers' beliefs into *connectionist*, *transmission* and *discovery* models based on their approaches towards the teaching of Numeracy. According to the report, the above orientations are merely *ideal types* and as such no one teacher fits neatly into any of the three orientations (pg. 24).

Although most studies on belief systems indicate a positive relationship between teachers' beliefs and classroom practice, (Clark and Peterson 1986; Fang 1996; Kegan 1992; Thompson 1984; Rueda and Garcia 1994; Dunne 1993; Stipek et al 2001; Peterson et al. 1989, among others), there is another school of literature, which argues that the relationship between beliefs and practice is not as clear-cut. Keddie (1971) asserted that we cannot assume that a direct relationship between teachers' attitudes and beliefs exist. In addition, Rueda and Garcia (1994) discovered that there might at times be notable variance between teacher beliefs and practices.

2.1.3: Influences on teachers belief systems

Powell and Solicity (1990:77) considered influences on teachers' beliefs as *'little packets of information'* that have derived from other people who have different views of the world, different experiences and different ways of selecting information from all that they perceive. Since much of this may be contradictory, the teacher somehow has to make sense of all these different viewpoints and shape his/her beliefs on those that appear most convincing. Since

several factors, (internal, external, personal and vicarious) may account for potential disparities between teachers' beliefs and their subsequent classroom practices (Fig 2.0). Hence, one could consider beliefs as a dynamic phenomenon, constantly exposed to shifts and changes.

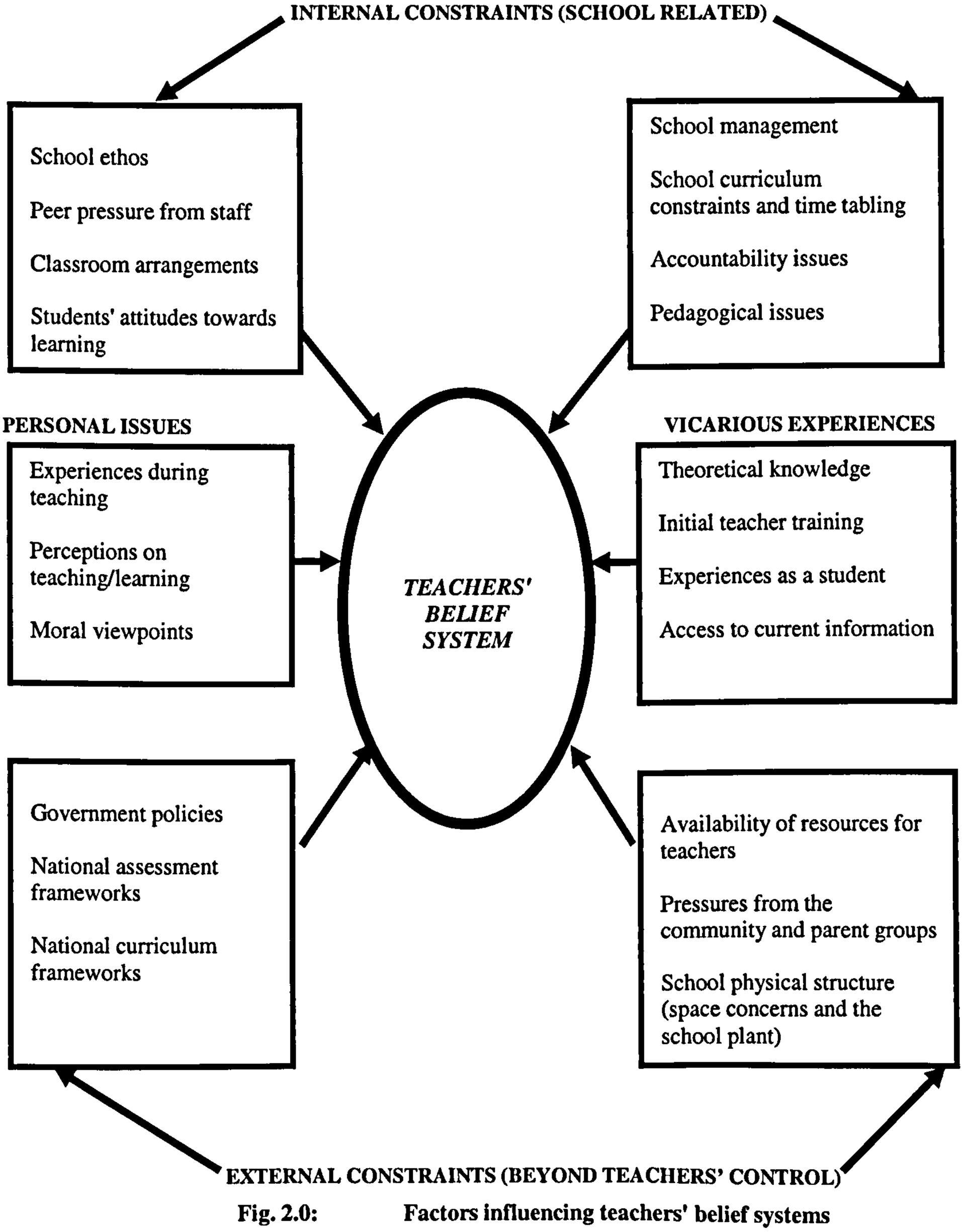


Fig. 2.0: Factors influencing teachers' belief systems

One of the major influences on teachers' perceptions and practices is the degree of pressure posed by respected peers. According to Zeichner et al. (1987:29), there is substantial evidence supporting the argument that beginning teachers' view their more experienced colleagues as highly influential in the process of learning to teach. They also believe that the norms existing within the teacher's peer group exert a powerful influence on teacher development. Mertz (1978) added that teachers might have differing beliefs and contrasting practices within the same school as a consequence of conflicting pressures by colleagues to influence them. Edgar and Warren (1969) however opposed the above viewpoints in their belief that colleagues and the contextual effects of the workplace are not of great important in explaining teachers' socialisation and practice.

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According to Lortie (1975), pre-training experiences profoundly influence teachers' beliefs and subsequent actions. Lortie believed teachers spend thousands of hours in an 'apprenticeship of observation' as students themselves and the internalisation of such teaching models greatly influence future practice. Curriculum and assessment frameworks also influence teachers' beliefs and subsequent practice. Hence, one can argue that when teachers are under pressure to complete the school curriculum they may adopt approaches that facilitate teaching as opposed to those which favour real learning. On occasions, assessment regimes may influence teachers' beliefs and subsequent practice. This is particularly true with high stakes examinations where schools are held accountable for students' performance.

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According to Richardson et al. (1991), where there is a lack of correlation between beliefs and classroom practice, it may indicate that the teacher is going through some change process.

Hence, on these grounds, changes in beliefs may precede changes in practice. The latter suggestion may however be in contrast to models of staff development that are based on the notion that changes in belief follow changes in behaviour. One such argument is based on the perception of Guskey (1986). According to Guskey, teachers only change their beliefs when they recognise positive results to students' learning based on their change in practice. However, Richardson et al. (1991:579) argued that the provision of practice without theory might lead to mis-implementation or no implementation at all unless teachers' beliefs are congruent with the theoretical assumptions of such practice.

If it can be successfully argued that there is some congruence between teachers' belief and practice, then according to Thompson (1984:106), '*...teaching must begin with an understanding of the concepts held by teachers and how they are related to their instructional practices'*. A lack of such understanding will inevitably result in misguided attempts to improve the quality of instruction in schools.

2.1.4: Teachers' implicit and explicit theories as a foundation for belief systems

Spodek (1988:13) believed in order to understand the nature of teaching, one must not only understand the behaviour of teachers but also teachers' thought processes regarding teaching, and implicit theoretical systems that drive these processes. Fenstermacher (1978:173) argued that research on teaching has placed much more emphasis on teacher behaviour than on teachers' thought processes. He believed the latter is due to two main reasons. Firstly, a teacher's thought is not a subject of empirical enquiry since 'it is accessible only by inference'.

Secondly, the 'causative factors' that account for a person's behaviour are external to the person.

Studies of teachers' belief systems have been criticised for their failure to address the action oriented frameworks and perspectives by which teachers make sense of and interpret their experience. Yaxley (1991:1) suggested that two fundamental questions must be asked about teachers' theories of teaching namely:

- *How we come to know what we know about effective teaching?*
- *How do we justify making these claims?*

Eraut (1994:26) argued that theory is often explicit in *'book knowledge'* but is implicit in '*action knowledge'*. The latter argument assumes that 'action knowledge' is that which base is characterised by *practice*. Eraut contended that private theories are ideas in people's minds that are used to interpret or explain their experience (pg. 59). He believed these may be private versions of publicly available theories or they may not be traceable in any publicly available form. Eraut further asserted that the use of these theories may not be explicit and as such they may only be inferred from observing one's behaviour. Carr (1987:165) argued since practice presupposes a coherent set of assumptions and beliefs a framework of theory always guides practice. Thus, according to Carr, in this view all practice is '*theory laden*'.

Yaxley (1991) believed teachers are not always aware of their theories of teaching and it is only when challenged to justify actions they attempt to articulate and bring to the surface these theories. Dunne (1993) was of the view that teachers have implicit theories about teaching and learning that guide both their planning and their decision-making in classrooms. Argyris and

Schon (1974) contended that professional action is based on implicit theories in use, which differ from *espoused* theories that are used to explain them to external audiences or even to the actor himself. Ghaye and Ghaye (1998:5) considered *espoused* theories as what we say or claim we do, or want to do.

According to Kilbourn (1992:71), every teacher has a philosophical view about teaching which guides classroom practice. He suggested that on one end of the continuum, such view may be implicit and unsystematic and at the other end of the continuum, articulated and internally consistent. Yaxley (1991) claimed that as the public evaluation of teaching increases, teachers will be obliged to bring to consciousness and publicly justify both their implicit and explicit theories.

Carr and Kemmis (1986) adopted a radical viewpoint on the concept of teachers' theories in their contention that the notion of teachers having 'a theory' may be unacceptable and is a 'misuse' of the concept of theory. They argued that much teacher action is the product of custom, habit, coercion and ideology that constraints action in ways that teachers themselves do not recognise and in ways by which they would not deliberately choose (pg. 189). The latter argument which considers habit as a rationale for action hardly appears convincing particularly when one considers the practice of novice teachers. It could be argued that *habit* is mainly a result of experience. Since novice teachers do not possess the qualities that are attributed to experience, most enter the classroom with a wealth of '*second hand*' knowledge. These may be gathered from interaction with other teachers or their perceptions of teaching

from their years of being a student. This would mean that novice teachers possess some logical theory of teaching and learning that cannot be attributed to habit.

The question therefore remains; *how best do we challenge values, beliefs and assumptions that may adversely influence student learning?* According to Schon (1983:61) practitioners may miss important opportunities to think about and improve practice as it becomes more repetitive and routine. Elbaz (1990) argued that tacit knowledge and routines of teaching, while important for survival, do not contribute to expertise. Hence, in attempting to improve practice, teachers must be made to realise that their existing practice may be inadequate.

2.1.5: Studies relating to the impact of teachers' beliefs on their classroom practices

Bahar et al. (1996) conducted a study in order to assess the influence of teachers' beliefs on instructional practices and on students' grades as a result of a curriculum innovation. The innovation involved differentiated and individualised instruction to classes of heterogeneously grouped 'honours' and 'regular' students. A series of lessons were also observed in order to determine the instructional strategies used by teachers and feedback was obtained at the end of lessons. The researchers also surveyed a randomly selected group of students in order to assess their beliefs about the curriculum innovation.

The findings indicated that initially, teachers were confused as to who had actually made the decision to implement the curriculum change. They reported that it was mainly an administrative decision and expressed concern about the suddenness of the decision and the lack of adequate preparation. Many teachers complained that they had neither the time, nor the

level of guidance required to implement the new programme. At the end of the first year, teachers felt that the innovation had gone hopelessly wrong and had little chance of becoming better in later years. They also complained that the administration did not provide the necessary support to see the innovation through (Bahar et al. 1996).

The lesson observations revealed that there was predominantly whole-class instruction and minimal emphasis on re-enforcing concepts, checking for understanding or eliciting feedback from students. There was also little evidence of differentiated instruction, which was to be the main aspect of the approach. Teaching was influenced by a lack of understanding of differentiation and individualised instruction. However, there was an attempt to differentiate during assignments, although this often just meant that the higher level (honours students) were assigned more homework or papers than their lower level counterparts (regular students).

An analysis of students' attainment revealed increases in English grades and a simultaneous decrease in Mathematics attainment, which the researchers attributed to differences in beliefs, related to the innovation. According to the researchers, the increased attainment in the English Department was due to the fact that the Chair of the department felt that regardless of the manner through which the new programme came about, it was both practical and useful. Such optimism spread through the department and eventually the entire department came to share her views. In contrast, the Social Studies teachers were vocal about their beliefs on student learning and were opposed to the increased freedom of choice given to students. The latter was displayed in their passive methods of instruction (pg. 6). The Mathematics department also disliked the innovation and held a strong belief that differentiation within the same classroom

was virtually impossible. This belief was also reflected in their traditional whole-group instructional methods.

The survey results concluded that students favoured the social aims of the curriculum innovation but were critical of its academic aims. On the social front, they felt that the new programme made the regular students feel equal to the honours' students (pg. 5). They also indicated that they felt little pressure because there was no division between students. However, on the academic front, they believed that they were not given adequate individual attention since the classes were now much larger and had a wider range of abilities. They also reported that students from lower ability levels required much discipline from teachers and consequently this adversely affected the learning environment. The students also felt that teachers were unable to deliver the differentiated curriculum and they described the teachers as 'unprepared' and 'disorganised' (pg. 4).

Bahar et al. (1996) concluded that the lack of success for the innovation was mainly due to the fact that the school culture was inconsistent with teachers' needs for autonomy and that a supportive environment essential to effective innovation was not discernible (pg. 7). The researchers also concluded that most teachers felt they had no voice in determining whether or not to implement the curriculum innovation since it was thrust upon them by the administration. Hence, since teachers had no part in selecting the innovation, they did not feel a 'responsibility to work towards its success' (pg. 7).

Unlike other studies examined, detailed results of the latter study were included in this document partly due to the innovation's limited success. Of greater importance is the fact that it re-iterates the need for ensuring that all staff members are fully aware and supportive of whatever innovation is being introduced. It also demonstrates the need to inform the staff of the origin of the innovation and whose interest its implementation is designed to serve. Further, it is essential to consider staff's' prior beliefs and the extent to which they are congruent with the ideas of the innovation since convincing individuals of the need for change can be at its best, a very frustrating endeavour. It should also be noted that teachers need to be re-assured that a support network will be established in order to assist them in coping with the change process.

2.2: Implementing and managing educational innovations

Change is inevitable in all aspects of the education system. As Judson (1991) argued, nothing is certain but death, taxes and change (pg. 1). Morrison (1998:3) suggested that change is both irresistible and unstoppable. He believed change in education is inescapable and regardless of how one views society, education as a significant component in socio-cultural and economic renewal and development is caught up in change. Sarason (1982:9) added that no major social institution has been more subject to the pressures of change than the public school system. According to Senge (1990:57), yesterday's solution becomes tomorrow's problem. This means that there is a continuous search for methods of improving teaching and learning.

Change is needed because schools are affected by changes in society and to some extent what takes place in schools have a direct influence on certain aspects of society (Nicholls 1983). As

stated by Sikes (1992), a fundamental purpose of education is to prepare young people for life in society and since societies throughout the world are constantly changing and developing, schools as institutions of society can also be expected to change. Darlin et al. (1993:5) suggested that schools cannot be indifferent to many of the fundamental changes in the environment. They see the school as the unit of change since all forces created by political, economic, social and cultural aspects of society, meet at one place, which is the school. Fullan (1991:15) argued that the purpose of educational change is to help schools accomplish their goals more effectively by replacing some structures, programmes and practices with better one. The latter does not mean that schools should randomly respond to pressures from all elements in society, but rather responses should be deliberate, planned and adequately justified.

2.2.1: The difference between innovation and change

The terms innovation and change are often used interchangeably. However, according to Nicholls (1983) there is a clear distinction between these two concepts. Huberman and Miles (1984:1) defined innovation as,

> *'...a messy, rich process full of coercion and shared struggle, indifference and heavy involvement, uncertain results and real pay off'.*

This highly complex definition captures the essence of what innovation truly entails. Innovation is considered an idea or practice perceived as new by individuals or groups to which it is intended (Nicholls 1983; Rogers and Shoemaker 1971; West and Farr 1990. The authors argued that it is not necessarily the 'newness' in terms of elapsed time, but the perceived or subjective newness of the idea for the individual or group reacting to it. According to West and Farr (1990:11), all *'innovation'* in organisational terms is *'change'* but

not all change is innovation. Marklund (1972) and Noel (1974) supported this view in their assertion that an innovation must imply an improvement towards a pre-determined objective.

King and Anderson (1995) criticised the above arguments on the grounds that they do not take into account the scale or scope of the products, processes or procedures to which they apply. Hence, they believe that with such definition, change meeting their criteria, no matter how trivial, could be considered an innovation. Kimberly (1981) added that it is only sensible defining as innovations the changes that have a profound impact on the organisation to which they are introduced. According to Nicholls (1983:2), in the concept of education, the term innovation is rather strict since there is a commonly held belief that there is nothing really new in education.

Morrison (1998:13) defined change as a dynamic and continuous process of development and growth that involves recognition in response to *felt needs*. Nicholls (1983) added that *change* represents a continuous re-appraisal and improvement of existing practice, which can be regarded as part of the normal activity of curriculum development. Owen (1973) suggested that change calls for a response but innovation requires initiative. According to Judson (1991), change is considered *any alteration to the status quo in an organisation...that impacts either or both the work and work context of an individual* (pg. 10).

2.2.2: Who should control change?

Morrison (1998) suggested that one of the principles of effective management of change is its power to empower and to create win-win situations. Pascale (1990:126) contended that change

flourishes in a 'sandwich'. Hence, when there is consensus above and pressure below, things happen. The latter implies that both top-down and bottom-up approaches are necessary for effective change. Bottom-up models of change run the risk of chaos since participants may be distracted from the real goals of change due to a pre-occupation with leadership roles. On the other hand, top-down approaches may be limited in the sense that the change may be forced on participants and as such they may lack the motivation and interest to see it through (Fullan 1993:40).

2.2.2.1: The role of the principal in the change process

Nicholls (1983) argued that the role of the school head is paramount to the success of school innovation since his/her support is required at all phases. According to Fullan (1991) and Sarason (1982), the school principal is one of the key determining factors in the success or failure of an innovation. However, Judson (1991:2) argued that a manager cannot alone achieve acceptance of and support for a change. Judson believed that such an outcome requires input from those involved in its implementation. Hence, teachers play a pivotal role in the acceptance and subsequent implementation of educational change.

2.2.2.2: Teachers and the change process

Wideen (1992) argued that no major reform in our school systems would occur without the work of teachers. Clark and Christie (1997) suggested that a lack of teacher involvement in the direction and appropriateness of change alienates staff and 'dis-empowers' their voice. Hargreaves (1994) added teachers do not uncritically accept drastic changes to their work when these are suggested from outside since their reaction in such cases is one of sceptical caution. Bahar et al. (1996) argued that during the implementation of any innovative programme,

teachers' engagement in participatory processes and decision-making promotes ownership, a sense of commitment and collegiality. They believed change is fostered, and innovation has the greatest chance of success when teachers are allowed control and decision-making ability to implement school innovations and engage in new teaching practices.

2.2.2.3: The role of students in the change process

In addition to the role of teachers in the implementation of change, students also play a vital part in the success of any school innovation. Hence, students should not be forgotten during the implementation of education innovations since innovation requires a change in teacher activity, which leads to a subsequent change in students' roles. According to Fullan (1991), innovations and their inherent conflicts often become ends in themselves and students get thoroughly lost in the shuffle. Fullan argued that unless students have some meaningful role in the enterprise, most educational innovations would fail (pg. 170). According to Fullan, students need to be treated as individuals whose opinions matter during the introduction and implementation of reform in schools.

2.2.2.4: The role of the change agent

Certain qualities of the change agent may also affect the success of an innovation. Wiseman (1997:11) argued that the extent to which an innovation is adopted will depend on participants' view on how much the change agent is '*one of us*'. This reflects teacher attitudes that if the change agent has status within, and respect from the host community, the potential implementers might, at the very least, consider the validity of the innovation.

2.2.3: Models of innovation

Schon (1971:81) developed a two-phased model of innovation. Firstly, he identified the *Centre Periphery* model (Fig. 2.1). Schon believed the effectiveness of this model, among other conditions; rest on the availability of resources at the centre, the extent of the diffusion and the energy needed to gain new adoption. Failure, he acknowledged, exists when the system exceeds the resources or when the energy at the centre mishandles feedback.

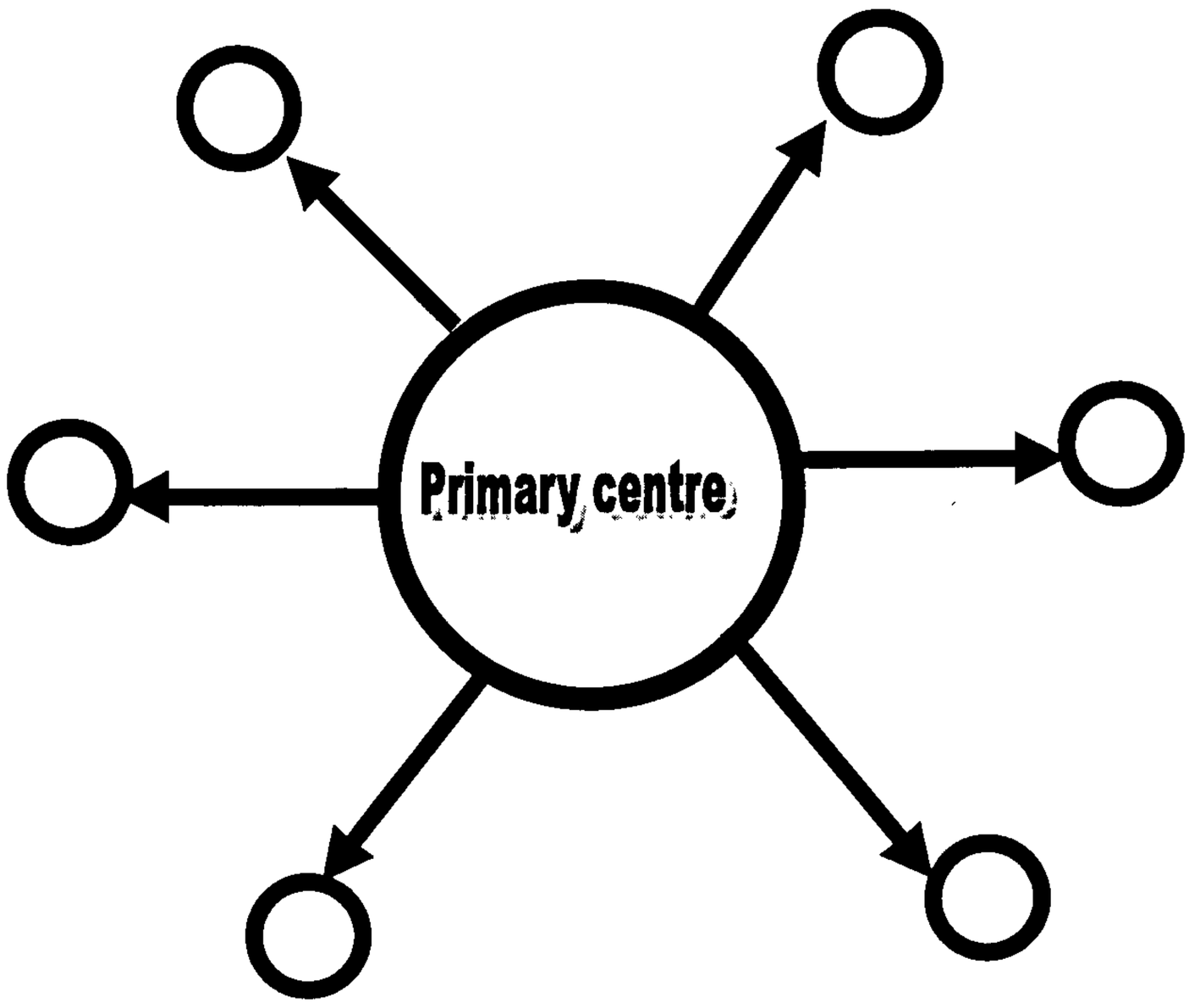

Fig. 2.1: The Centre Periphery model of diffusion of innovation. (Adapted from Schon, 1971)

Schon's second model the *proliferation-of-centres* is designed to extend the limits of the innovation and to overcome potential sources of failure. It recognises primary centres that support secondary ones engaged in diffusing the innovation (Fig. 2.2). The system maintains the basic *centre-periphery* structure but differentiates primary centres from secondary ones.

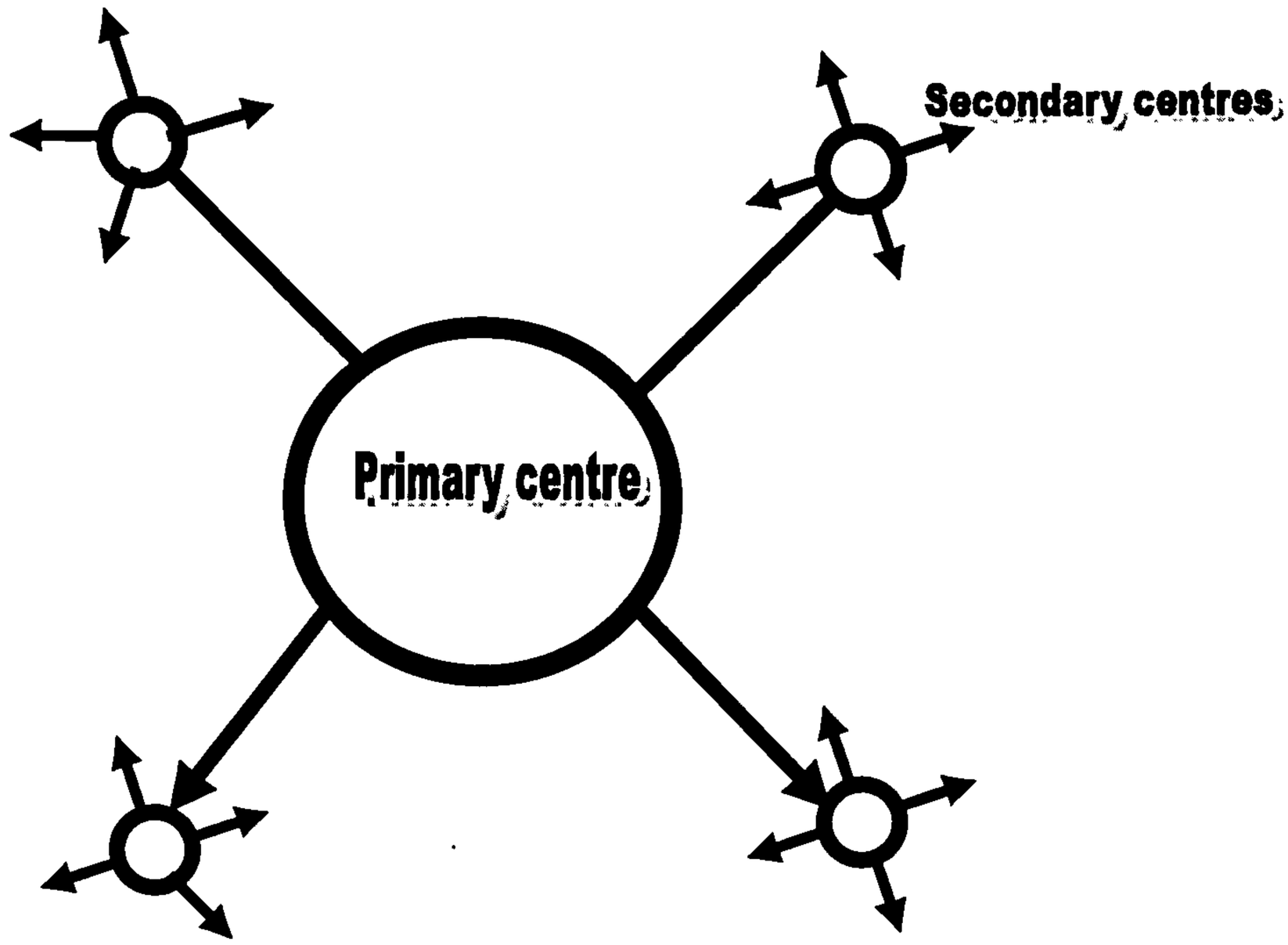

Fig. 2.2: The proliferation of centres model of diffusion of innovation. (Adapted from Schon 1971)

In this model, the secondary centres engage in the diffusion of the innovation while primary centres support and manage secondary ones (Schon 1971:85). The latter increases the efficiency of implementation. The model involves training of trainers and as such teachers may be trained to act as secondary centres of diffusion, thus offering their expertise to those adopting the innovation.

Morrison (1998) identified a 'three-step' model of innovation based on the work of Lewin (1952), with an attempt to establish a degree of permanence in new change and to overcome resistance to the initial state after the impetus for change has receded. He considered the first step as *unfreezing the current situation*, the second step as *moving to the new situation* and the third step as *refreezing the new situation*. *Unfreezing* involves an investigation of resisting

forces with the hopes of minimising such forces in preparation for the change. When these forces are minimised, the change can then be implemented. Burnes (1996) suggested that the process of *unfreezing* requires recognition that existing practices are no longer effective, a reduction of forces maintaining present behaviour and some form of re-education for participants (pg. 182-183).

2.2.4: Effective implementation of innovation

According to Rogers and Shoemaker (1971:155) the following five characteristics determine effective implementation of innovations:

- *Compatibility:*

This relates to the extent to which the innovation is perceived by potential users as being consistent with their existing beliefs and values, past experiences and current needs.

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- *Complexity:*

Complexity is considered the degree of difficulty in implementing the innovation. Such difficulty may be due to the complexity of the innovation itself or the lack of adequate explanation.

- *Triability:*

This relates to the extent to which the innovation can be piloted before implementation. Initial test assists in minimising the risks involved during implementation.

❖ *Observability*

The term refers to the degree to which the results of an innovation are visible to others.

❖ *Relative advantage:*

Relative advantage relates to the extent to which the innovation is seen to be better than the practice that it succeeds. The relative advantage may also be weighed against the degree of difficulty of the change process.

2.2.5: A look on the other side of innovation

2.2.5.1: Does innovation necessarily mean improvement?

King (1990:31) suggested that literature on innovation generally argues that innovation is *'a good thing'* and consequently resistance to innovation is *'a bad thing'*. According to Rogers (1983), innovation research is marred by two pervasive biases. Firstly, he recognised an individual bias that seems to indicate that since the shoe does not fit, there is something wrong with the feet. Secondly, there is a pro-innovation bias that sees innovation as a unified advantage, whatever the situation. According to Nisbet (1980), the relationship between growth and progress has seduced us into falsely assuming that change is development. Fullan (1991:93) added that not all change is, or even meant to be progress. He was of the view that only a fraction of innovations are based upon the identification of clear and important educational needs. According to Fullan there are many competing versions of what should be done, with each set of proponents equally convinced that their version is correct.

One major problem of innovations is the subjective assertion that innovations are always more successful or more effective than current practice. The decision to implement innovations and their intended benefits are not always universally agreed. Hence, actions appearing efficient, practical and logically for one individual, may appear inefficient, impractical and illogical for others. Taking the latter into consideration we are left with the fundamental question of *who is to decide on the implementation of innovations and on what basis are such decisions to be grounded?'*

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According to Nicholls (1983:5) one of the problems associated with innovation is assessing improvement. The difficulties involved with educational innovations have led to a situation in which teachers involved in innovations are always weary of, and have often ignored any evaluation of their actions. This leads to another fundamental question; *who is to decide what is effectiveness and what are the criteria for measurement*? Fullan (1982:112) suggested that change could be a two-edged sword in that it could either aggravate the teachers' problems or provide a glimmer of hope. Hence, different teachers within the same institution may respond positively or negatively. Such decision may be due to personal and professional experiences and levels of motivation among several other factors.

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Huberman and Miles (1984) argued that the term improvement is in itself problematic since one person's version of improvement may be another person's version of wastefulness or even worsening of schools. They believed that improvement sometimes turns out to be merely a code word for the directives that administrators have put into place, or for the agreements that teachers have been lobbied into (pg. v). Fullan (1991) contended that we should strive to find

meaning in assessing specific innovations and be suspicious of those that do not make sense, since the goals of education and the best means of achieving them are not always clear or unanimously agreed.

2.2.6: Problems associated with innovation

Stacey (1992) considered the change process uncontrollably complex and in many cases unknowable. Fullan (1993:49) suggested that it is difficult to foster changes in instructional practices since to '*restructure*' does not mean to '*reculture*'. Nicholls (1983:1) added that the lack of success in innovations has been seen as the replacement of one rigid static practice with another. According to Nicholls, among the more general factors that inhibit innovations are traditionalism, laziness, fear and insecurity (pg. 9).

2.2.7: Resistance to innovation

Leigh (1988:69) defined resistance as any conduct that tries to maintain the status quo in the face of pressure to change it. Minimising resistance is a key factor in the successful management of innovation (Morrison 1998). According to Owen (1973) resistance arises from a mixture of misunderstanding, ignorance, fear, the heavy burden of work associated with innovation and the desire of some teachers to take the easy way out. Buchanan and Boddy (1992) were of the view that people will most likely resist change that adversely affects their power, influence, responsibility, autonomy and access to information. They contended that handling innovation effectively requires minimising individuals' loss of power and influence, offering new opportunities and attractive trade-offs for potential losers.

Resistance may also be due to a high level of tolerance with the existing conditions. Schon (1971:11) used the term stable state to explain this phenomenon. According to Schon, belief in a stable state serves primarily to protect individuals from apprehension of the threats inherent in change. Hence, the more radical the prospective innovation, the more vigorous the defence and therefore the more urgent the commitment to the stable state. Judson (1991:54) suggested that resistance to innovation occurs when there is conflict between the goals and interests of the group and that of the organisation or the change agent as a whole. He suggested that indifference might appear as an active avoidance of pertinent issues by introducing and focusing on subjects that are irrelevant to the problems at hand.

Whitaker (1993:62) identified the following resistance strategies commonly voiced in opposition to change initiatives:

- *We have tried that once before and it did not work*
- *We don't have the time*
- *Let's get back to reality*
- *We don't have the resources*
- *You can't teach an old dog new tricks*
- *Not that again!*
- *We have managed so far without it*
- *Let's form a working party*
- *It won't work in our department*
- *Let's wait until things settle down*
- *We've always done it this way and no one has complained.*

Rudduck (1990:5) added that teachers feel that they have been through a period of intense change whereas classroom researchers find it difficult to find evidence of such change.

According to Plant (1987), resistance occurs in two forms namely systematic and behavioural. Systematic resistance occurs due to inadequate knowledge, information or skills. Behavioural resistance, on the other hand, is based on perceptions and assumptions of individuals within the organisation. Burnes (1996:320) suggested that if proposed innovation is inconsistent with the attitudes, beliefs and practices of those affected, then resistance should be expected unless those affected are prepared to change their attitudes.

Fullan (1991) believed that in order to minimise resistance, it is essential for educationists to identify facilitating and inhibiting factors at the key stages of an innovation. Lewin (1952) developed the force field analysis in order to map potential sources of support or resistance to change. Several modified versions of such analysis have been developed and one such version is that of Morrison (1998) [Fig. 2.3]. The force field analysis is useful because, according to Leigh (1988), it stimulates new ways of taking action. It may also encourage a more optimistic view, directing a search for those vulnerable points where the right action will tip the balance, starting a move away from the present status quo. The school staff may also be allowed to participate in the process of identifying 'facilitators' and 'inhibitors' to the innovation.

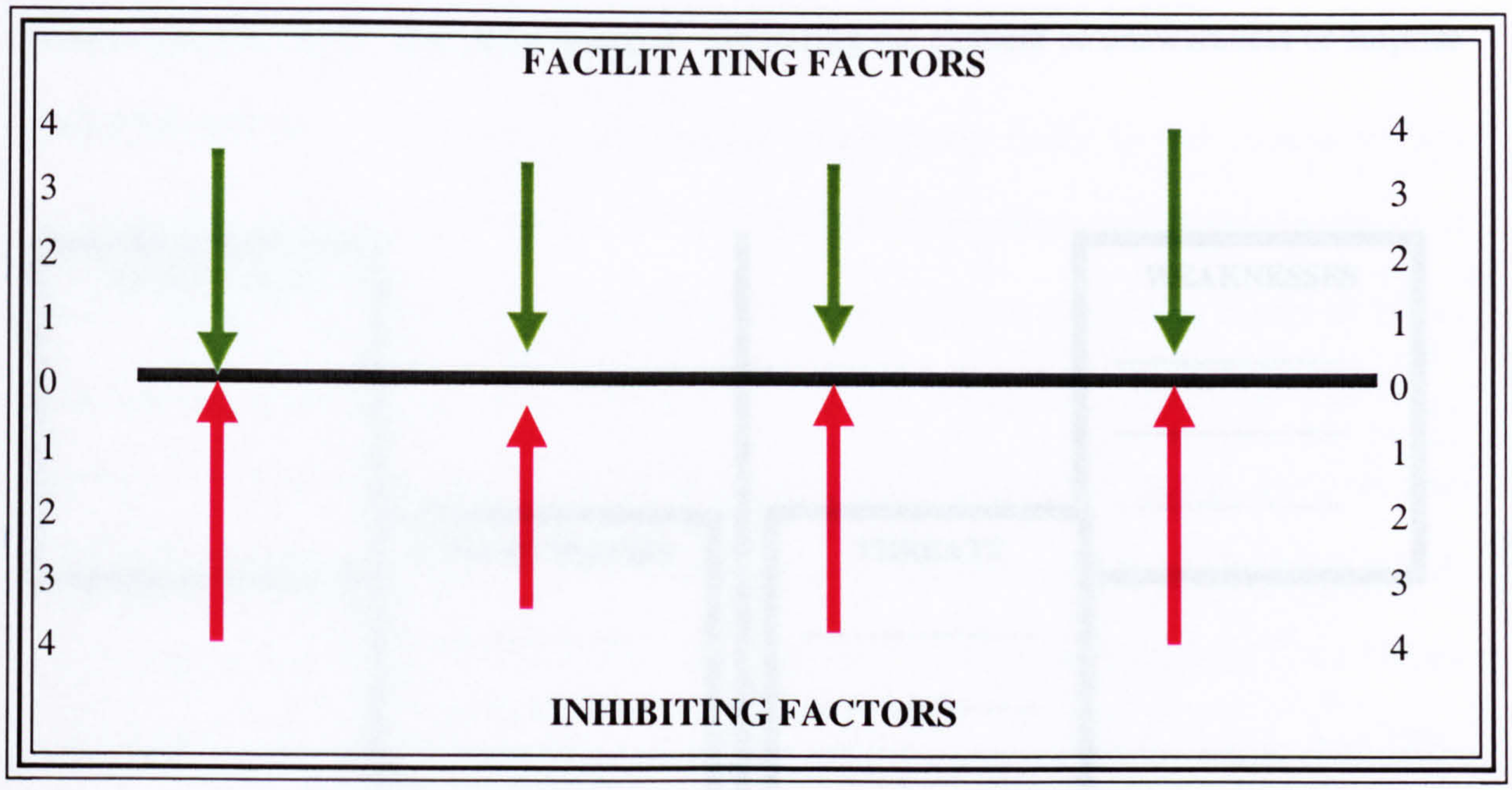

Fig. 2.3: A force field analysis for assessing influences on innovation (Adapted form Morrison 1998).

As stated by Leigh (1988:158), the force field analysis begins with the assumption that at any given moment, any situation in an organisation is in a state of equilibrium. Hence, in an organisation there is a dynamic tension between the 'restraining' and 'driving' forces that maintain the status quo. Leigh believed change is possible only when one or both of the following occur: restraining forces weaken and/or driving forces strengthen. Hence, when the equilibrium of driving and restraining forces is disturbed, change occurs towards or away from the desired goal.

Another method of identifying potential challenges and opportunities is through a SWOT analysis. With a SWOT analysis, the strengths, weaknesses, opportunities and threats to innovation are identified (Fig 2.4). McWhinney et al. (1997) argued that such methods direct a group to look at the worst and best outcomes in the change process. Hence, it highlights some of the potential tensions and possibilities that exist in the context of innovation even before

actual implementation. The latter assists in minimising the element of unawareness or surprise during the process.

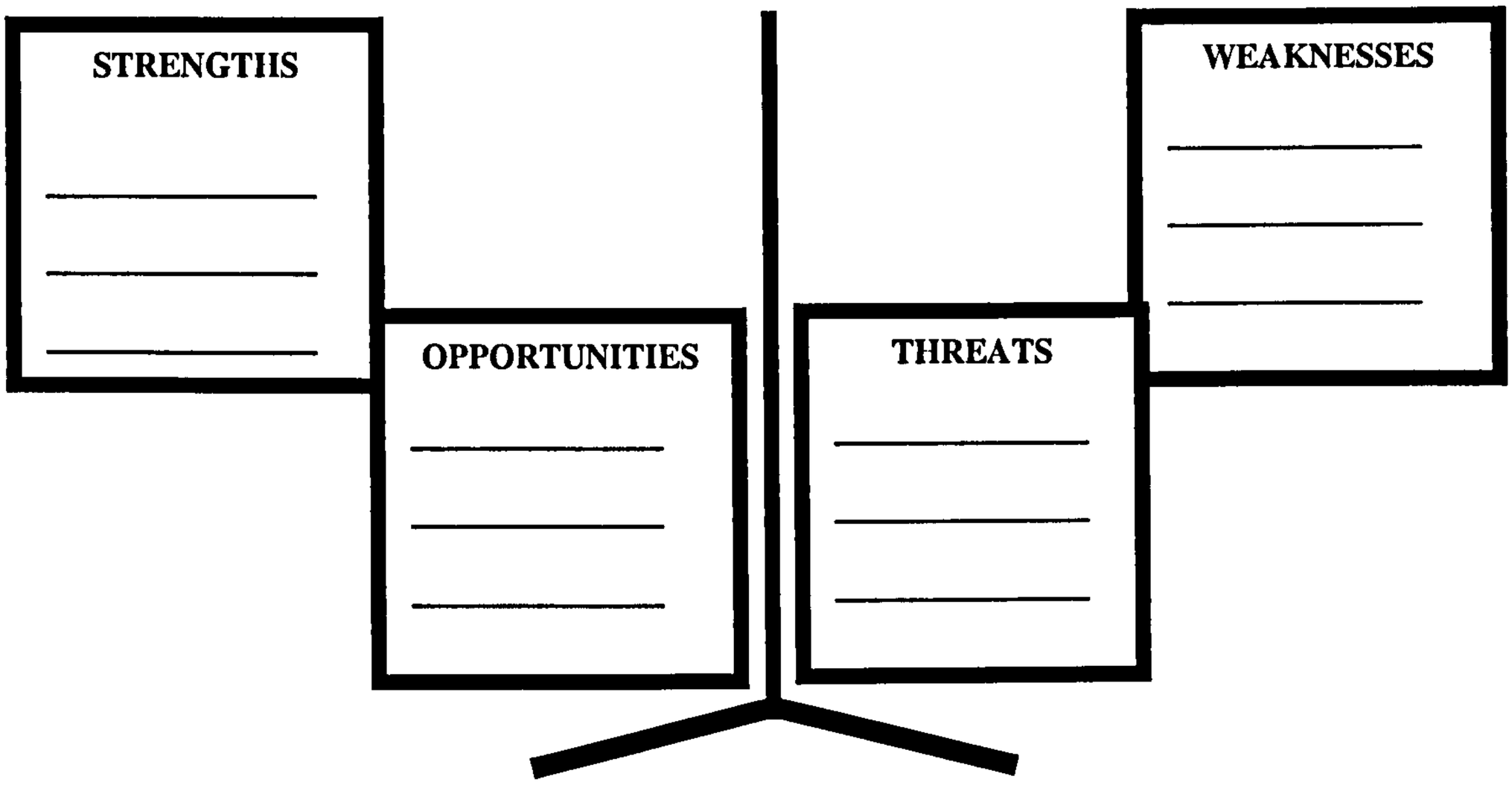

Fig. 2.4: A SWOT analysis for mapping the potential outcomes of innovation

2.2.8: The positive aspects of resistance

Resistance to innovation and change should not always be viewed in a negative sense, since there may be potential advantages to resistance. Zaltman et al. (1973:85) believed the very concept '*resistance to change*' has deprecatory connotations, as if it were some kind of personality flaw endemic amongst those subordinate to the innovation. Leigh (1988:74) considered resistance as a positive asset in the sense that it challenges assumptions and helps stimulate the development of mutually acceptable goals. In addition, it may also assist in preventing stagnation, allowing problems to be aired and alternative solutions to be discussed. Resistance may also assist in modifying end results making them more realistic and acceptable.

2.3: Organisational culture

The culture of an organisation is an essential underpinning factor in the success of any innovation since according to Morgan (1986:138) effective organisational change incorporates culture change. Sikes (1992) argued that the concept of *cultures of teaching* is crucial to any consideration of change because it is through cultures that change is mediated, interpreted and realised. As stated by Darlin et al. (1993), meaningful educational change demands new perspectives and basic changes in the culture of schools. Culture consists of the norms, beliefs and assumptions embraced by the organisation, which has been developed during its history and manifested in the material arrangements and behaviours of its members (Sergiovanni 1984; Nystrom 1990; Brown 1998). Burnes (2000) was of the view that culture legitimises certain forms of action while it prohibits others (pg. 161). He believed no organisational culture is static and as the factors that influence culture changes, so will the organisation's culture.

Deal and Kennedy (1983a) succinctly defined organisational culture as '*the way we do it around here*' (pg. 14). According to Deal and Kennedy (1983b), when culture works against you, it is nearly impossible to get anything done (pg. 4). Hence, any attempt at improving schools that does not address the underlying organisational conditions can be viewed as doomed to tinkering (Fullan 1992a). Hargreaves (1992; 1994) identified the sub-cultures of individualism, collaboration, contrived collegiality and balkanisation within organisations (Fig 2.5).

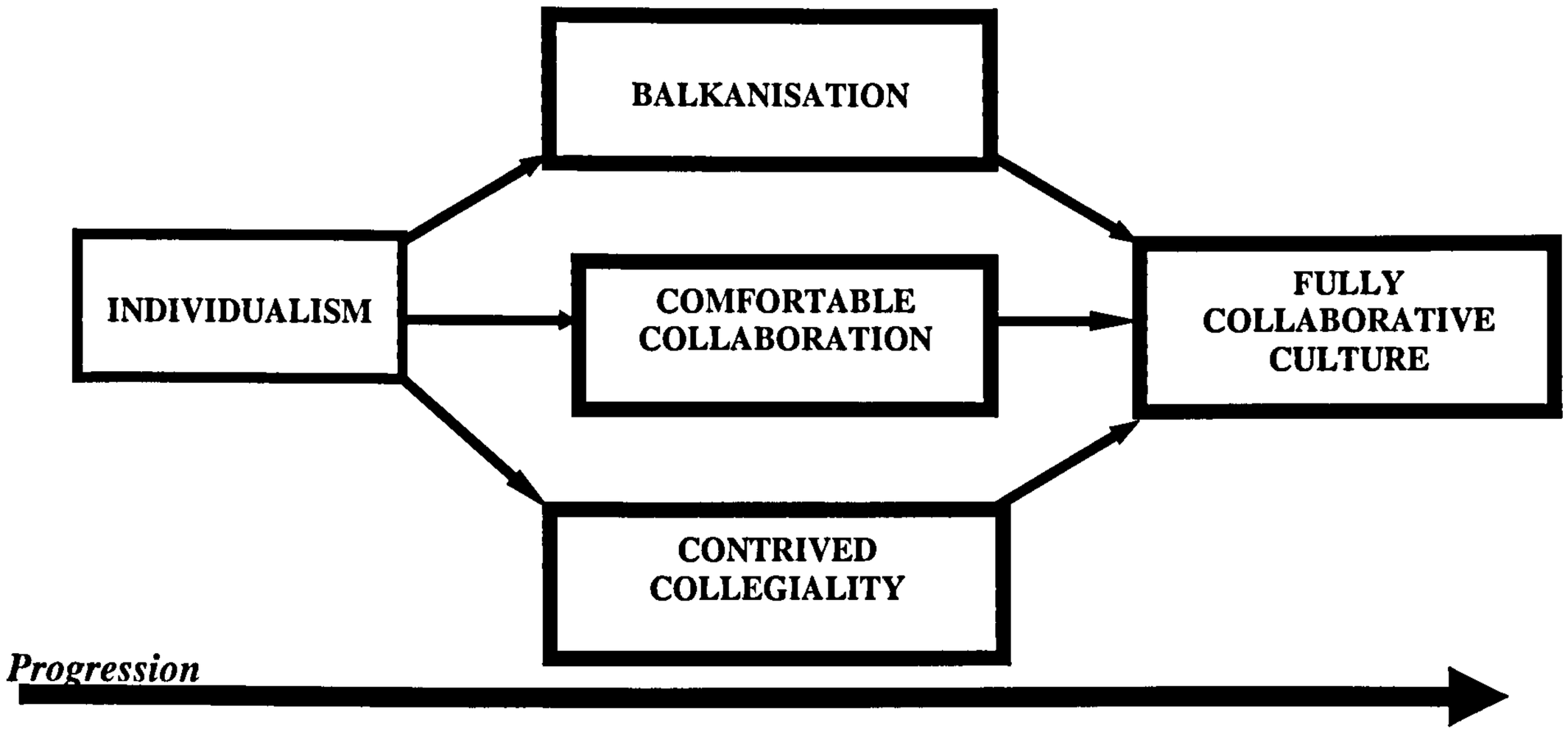

Fig. 2.5: School sub-cultures (Adapted from Hargreaves 1992)

2.3.1: The culture of individualism

This relates to teaching in isolation with little or no communication with professional peers. Individualism involves the power to exercise independent, discretionary judgement and a withdrawal to delve into ones personal resources. This often comprises teaching *behind closed doors* and away from the possibility of feedback. Hargreaves (1994) believed the culture of individualism is associated with defensiveness, anxiety, and fear of flaws and failure in teaching.

2.3.2: Contrived collegiality

Contrived collegiality represents working relationships that are not spontaneous or voluntary. Instead, they are administratively regulated, compulsory, implementation-oriented, fixed in time and predictable (Hargreaves 1994:196). Hargreaves suggested that two of the major consequences of contrived collegiality are inefficiency and inflexibility.

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2.3.3: Balkanisation

This relates to a culture where teachers work neither in isolation, nor with their colleagues or the whole school, but in smaller sub-groups within the school community. The latter on its own however does not necessarily constitute balkanisation. Balkanisation, according to Hargreaves (1994), possesses distinct qualities. Firstly, there is low permeability since sub-groups are strongly insulated from each other. Secondly, the sub-groups once established, remain relatively stable with a high permanence over time. Thirdly, there is a strong sense of personal identification such as socialisation into particular subject specialisms and a view of the world from the standpoint of these subjects. Finally, there is political complexion where sub-cultures represent areas of self-interest. Hence, promotion, status and resources are frequently distributed between and realised through membership of these sub-cultures.

2.3.4: The culture of collaboration

Collaboration relates to spontaneous and voluntary partnerships without an external control agenda. Hargreaves (1994) suggested that collaboration and collegiality have been advanced as being particularly fruitful strategies for teacher development. According to Hargreaves (1994:195), full collaboration may comprise joint work, mutual observations and focused reflective inquiry in ways that extend practice critically, searching for alternatives in the continuous quest for improvement.

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There is a fine line between innovations that enhance organisational growth and development and those serving to fulfil desired ends. Fullan (1991) argued that in order for reforms to be successful, individuals and groups must find meaning concerning what should change as well

as how to go about it. Hence, educational change must be meaningful if it is to do what it purports, improve teaching and ultimately student learning.

2.4: Professional development and teacher education

The concept of professional development has been used interchangeably with terms such as staff development and in-service education (Dean 1991; Glover and Law 1996; Fullan 1992b; Garrett and Bowles 1997). Many authors however have drawn clear distinctions between professional development and staff development (O'Neill 1994; Fidler 1997; O' Sullivan et al. 1997). Guskey (1986) argued that staff development programmes represent a systematic attempt to bring about change in classroom practices of teachers, in their beliefs and attitudes and in the learning outcomes of students. Jones et al. (1989:12) believed staff development serves as a method for teachers to experience continuing professional education as part of a team of professionals. They viewed professional development, on the other hand, as the broader career and personal development of individuals.

Morant (1981:1) differentiated between professional development and in-service education in his view that in-service education is intended to assist the professional development that teachers ought to experience in their working lives. According to Morrant, in-service education aims to widen and deepen teachers' knowledge, understanding and expertise with respect to their professional work by means of activities primarily designed to achieve this purpose (pg. 3-4).

Dean (1991:27) suggested that professional development is not something *'done to teachers'*, but a process in which they are a vital part at every stage. She contended that teachers are more likely to feel in control of the process of change if they see their own development as part of the school's development. As asserted by Wideen (1987), teachers are at the centre of any improvement effort and as such the work of teachers and the visions they possess about their work provide the starting point for development. Elliott (1977) considered professionalism as not attempting to control teachers' behaviour but rather helping them control it by becoming more aware of what they are doing.

According to Dean (1991), any attempt at professional development within the school must take into account the school culture if it is to be successful. She believes that there are three essential goals of professional development. Firstly, it must improve the learning experience for pupils in the classroom. Secondly, it should benefit the staff and thirdly, it should concern everyone in the school. O'Neill (1994) suggested the concept of professional development may be viewed on a continuum. At one end, its purpose is to serve as a medium for enhancing the capability of teachers so as to improve the quality of management of learning. In this sense, it is driven by a professionally determined agenda and as such, development is seen as process oriented (pg. 288-289). At the other end of the continuum, professional development may be seen as a means of ensuring effective and efficient curriculum delivery. The latter is an accountability perspective and the predominant focus is the performance of the professional.

Clarke (1994) suggested that one common approach to professional development is to attempt to create some sort of change in teachers' knowledge, beliefs and attitudes that may then lead to

appropriate changes in classroom practice and improved student learning. However, as Guskey (1986) claimed, teachers' beliefs and attitudes are likely to change only after they see evidence of changes in students' learning. This may due to the fact that teachers usually consider success in terms of resulting effects on student learning rather than their own actions.

2.4.1: Effective utilisation of professional knowledge

Hargreaves (1998:27) suggested that professional knowledge can be in three forms namely, *that shared by all teachers, that shared by some teachers* and *that locked up in the heads of individual teachers.* According to Hargreaves, schools make poor use of their collective professional knowledge. He was of the view that teachers need to find out what they know, not least because they know more than they think but because they also need to know what they do not know. In order to do this they must, however bring to light knowledge they did not realise they possessed (pg. 28). Hargreaves contended that a school cannot be a learning organisation if it is unaware of what it does and does not know, hence his matrix for investigating knowledge within the school (Fig 2.6).

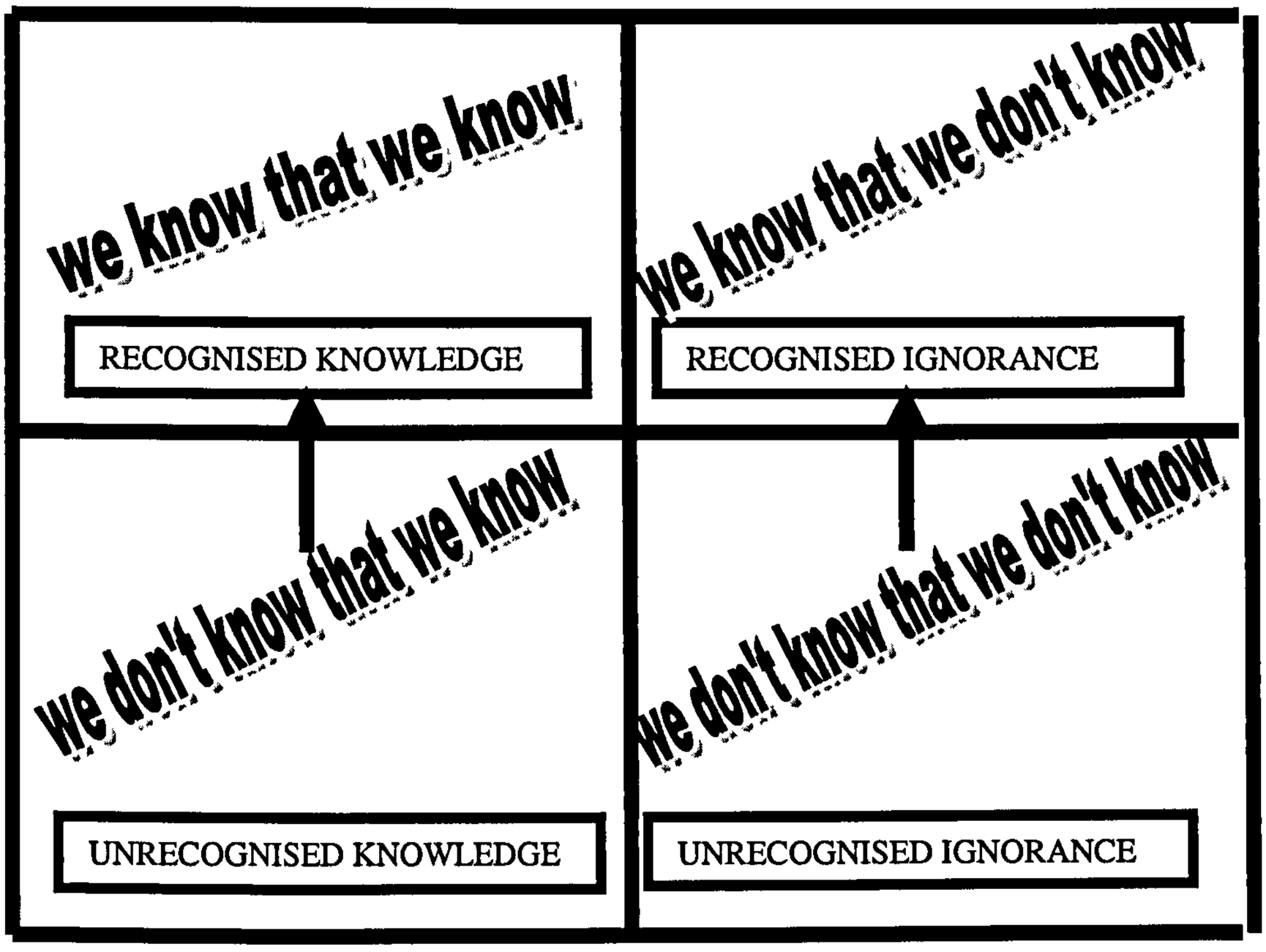

Fig. 2.6: Investigating professional knowledge. (Adapted from Hargreaves 1998).

Hargreaves identified several methods through which teachers could validate their professional practice. Among them, he considered teachers observing their colleagues during practice and providing objective feedback. He argued that teachers talk to each other about their practices but rarely watch each other at work or practice together with a self-conscious attempt to validate their practice. Such social validation, which Hargreaves termed *trial-and-improve tinkering* (pg. 33), is likely to be superior to self-validation but it is yet to be developed in most schools.

2.4.2: Teachers' experiential learning

West-Burnham and O'Sullivan (1998) contended that one of the most important aspects of managing professional learning is the choice of appropriate techniques to facilitate and support

learning. They argued that the purpose of professional learning is to enhance practice that is evidenced by the learning of students. Sprinthall and Sprinthall (1980) suggested that teachers learn in situations where they are provided with an opportunity for continuous guided reflection.

Schon (1983:21) challenged the traditional school of thought pertinent to the nature of professional knowledge in his view of technical rationality. He believed technical rationality rests on the separation of means from ends, of research from practice and of knowledge from doing. He recognised the practical competence of professionals and advocated an 'epistemology of practice' implicit in the artistic, intuitive process that practitioners bring to situations of uncertainty and instability. Kolb et al. (1995:259) presented a learning cycle that proposes a means of conceptualising the learning stages of professionals. Central to Kolb's model (Fig. 2.7) are four elements, namely concrete experience, reflective observation, abstract conceptualisation and active experimentation.

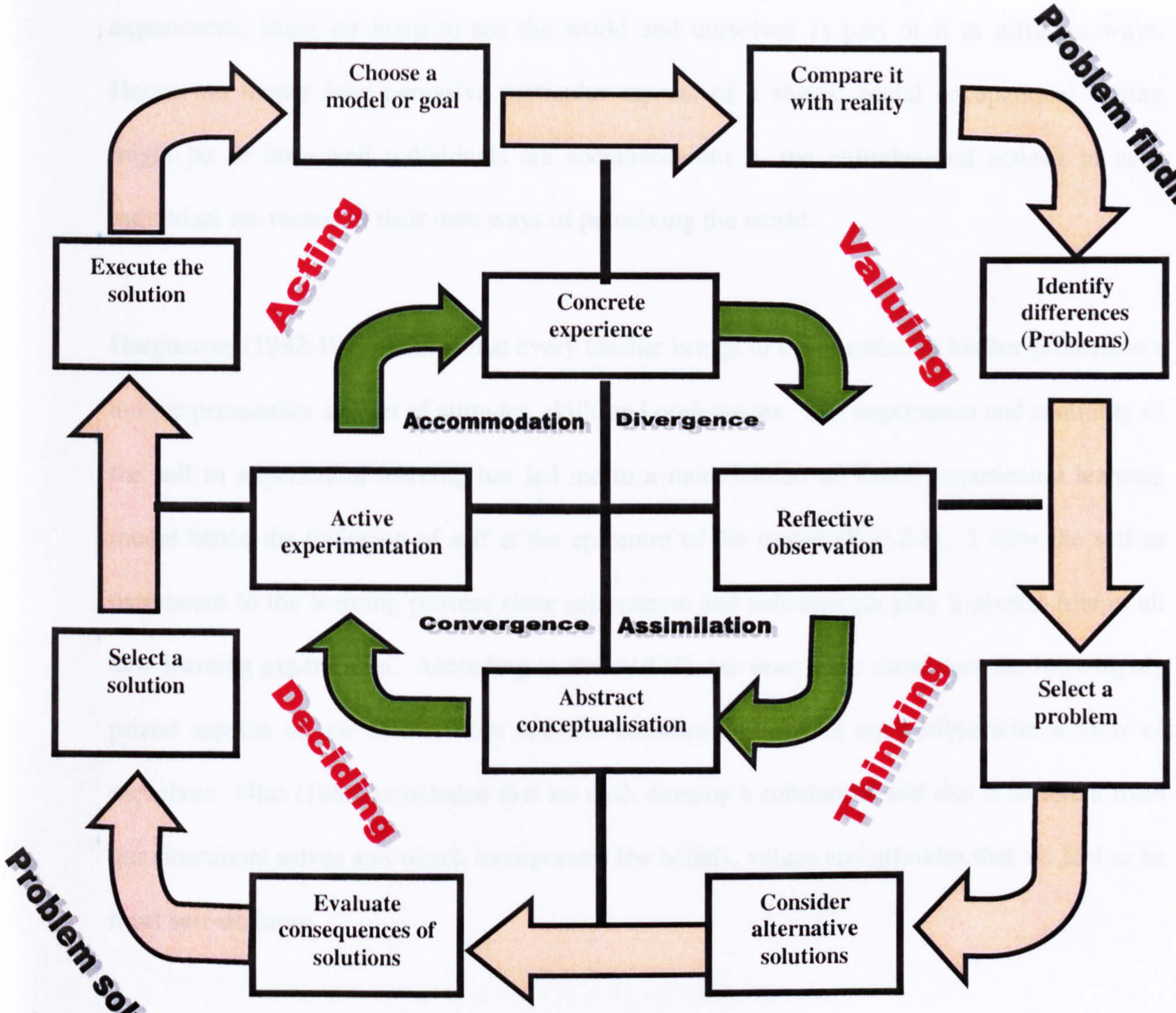

Fig 2.7: An experiential learning model for professionals. (Adapted form Kolb et al. 1995)

2.4.3: Professional learning and the concept of the self

The 'self' influences all aspects of the learning process. Hence, we might be confident and optimistic about ourselves at certain times but in other situations feel frustrated and unable to cope well. Whitaker believed the decisions and choices that we make in life are affected by this self-understanding. Nias (1989) added that the self is a crucial element in the way teachers construe the nature of their job. According to Nias, since no two people have the same life

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experiences, since we learn to see the world and ourselves as part of it in different ways. Hence, no matter how pervasive particular aspects of a shared social occupational culture might be or how well individuals are socialised into it, the attitudes and actions of each individual are rooted in their own ways of perceiving the world.

Hargreaves (1982:192) claimed that every teacher brings to the exercise of his/her profession a unique personality and set of attitudes, skills and preferences. The importance and centrality of the self in experiential learning has led me to a modification of Kolb's experiential learning model hence the inclusion of self at the epicentre of the model (Fig: 2.8). I view the self as paramount to the learning process since self-esteem and self-concept play a pivotal role in all new learning experiences. According to Ball (1972), our *inner core* comprises the most highly prized aspects of our self-concept and the attitudes and values compatible with a view of ourselves. Nias (1989) concluded that we each develop a substantial self that is different from our situational selves and which incorporates the beliefs, values and attitudes that we feel to be most self-defining.

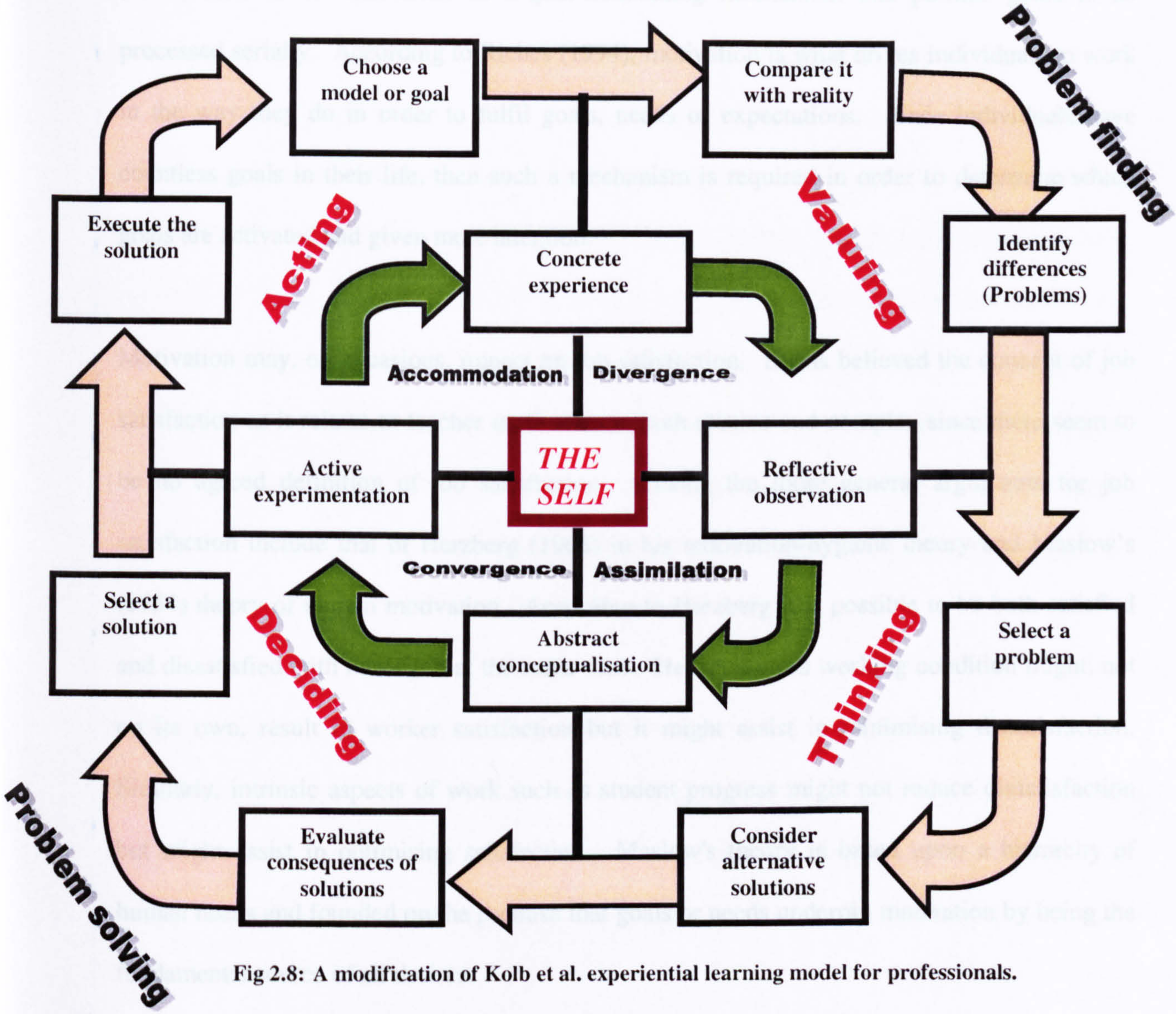

Fig 2.8: A modification of Kolb et al. experiential learning model for professionals.

2.4.4: Professional development and teacher motivation

Teacher motivation is considered an essential part of professional development because teacher motivation directly affects performance and potentials for professional growth. Evans (1998) defined motivation as a condition, or the creation of a condition that encompasses all those factors that determine the degree of inclination towards engagement in an activity. Simon

(1967) referred to motivation as a goal-terminating mechanism that permits goals to be processed serially. According to Riches (1994), motivation is what drives individuals to work in the way they do in order to fulfil goals, needs or expectations. Since individuals have countless goals in their life, then such a mechanism is required in order to determine which goals are activated and given more attention.

Motivation may, on occasions, impact on job satisfaction. Evans believed the concept of job satisfaction as it relates to teacher motivation is both elusive and complex since there seem to be no agreed definition of job satisfaction. Among the more general arguments for job satisfaction include that of Herzberg (1968) in his motivation-hygiene theory and Maslow's (1954) theory of human motivation. According to Herzberg it is possible to be both satisfied and dissatisfied with one's job at the same time. Hence, a good working condition might, not on its own, result in worker satisfaction but it might assist in minimising dissatisfaction. Similarly, intrinsic aspects of work such as student progress might not reduce dissatisfaction but might assist in optimising satisfaction. Maslow's theory is based upon a hierarchy of human needs and founded on the premise that goals or needs underpin motivation by being the fundamental source of all desires.

2.4.5: Measuring professional growth

According to Bodine (1973) self-assessment is probably the most powerful means yet developed for a teacher to be the master of his own professional growth. Hence, like opening a door, it allows a person to look and see what he/she is actually doing in the classroom. This process gives the teacher objective information about his performance in the classroom. Such

self-assessments could be undertaken in the form of reflective journals relating to teachers' own classroom practice.

Another approach to the evaluation of professional development is school-based evaluation. Radnor (1990) argued such methods ask searching questions about the nature of school practices. Hence, schools develop a critical perspective, challenging the underlying assumptions about practice (pg. 151). Glover and Law (1996:89) argued that where institutions develop evaluation processes there is evidence of considerable improvement in the quality of professional development provision. They however cautioned that a key problem in many schools is that the time used for evaluation detracts from that needed to implement changes or may over burden staff with 'yet another task'.

Further, appraisal is increasingly seen both as a method of identifying the professional development needs of individual staff and a way of evaluating the impact of professional development activities. According to Glover and Law (1996:40), the purpose of appraisal is to identify what the individual teacher feels he/she needs and for guiding professional development planning.

2.5: Reflective practice and teacher education

Reflection on practice serves as an essential method of enhancing professional growth. Dewey (1933) was one of the very first authors to mention the term reflection when he made a distinction between routine and reflective teaching. Dewey characterised reflective teaching as an active, persistent and careful consideration of means and ends and their relationship to

social, educational and political contexts (pg. 9). Dewey defined reflection as turning a subject over in the mind and giving it serious and consecutive consideration thereby enabling us to act in a deliberate and intentional fashion. According to Dewey, grounded in the practitioner's knowledge and experience, reflective thinking originates in directly experienced situations that are puzzling and uncertain. Dewey did not emphasise any aspect of time in his notion of reflection and therefore there was neither a retrospective or prospective element.

Rugg (1947) analysed reflection in a four-part process. First, he suggested that one recognises a problem and confronts it directly. Secondly, one calls up suggestions mainly from past experiences and then in imagination brings to consciousness things that might be done to find factors that might fit the situation. Thirdly, one tries them out, comparing and appraising, rejecting one or the other. Finally, one accepts one suggestion and acts upon it. One could argue that the above process, as proposed by Rugg (1947), appears deceptively simple considering the non-linear characteristic of actual reflection. According to Barlett (1990), reflective teaching involves a major shift in emphasis in our thinking and acting. Barlett believed that in becoming reflective practitioners, we are forced to adopt a critical attitude to ourselves as individuals (pg. 213-214).

2.5.1: Conceptualising the term reflection

The concept of teacher reflection has been the subject of immense interest in the educational arena, particularly in the past two decades. Many believe the concept has been inadequately defined (Kember et al. 1999; Hatton and Smith 1995; Zeichner 1993; Zeichner 1994, among

others). There is still ambiguity in exactly what the concept entails for classroom teachers and exactly what should be the object of reflection in classroom settings.

Shulman (1986) considered reflection as one stage in the model of pedagogical reasoning in which teachers look back on the teaching and learning that has occurred as a means of making sense of their actions and learning from their experience. Hullfish and Smith (1961) added that reflection is a reconstruction of experience. However, according to Mac Kinnon and Erickson (1992:198), the idea of *reconstruction* as proposed by Hullfish and Smith entails more than broadening ones range of attention to particular details and as such they considered reconstruction as a complete alteration of the situation. Grant and Zeichner (1984) considered reflection as an ongoing process that involves re-examination of what was done, and thinking analytically about goals and actions in order to achieve better results.

Calderhead (1989:43) contended that terms such as reflective teaching, teacher as researcher, teacher as decision-maker, teacher as professional and teacher as problem solver, encompass some notion of reflection in professional development but disguise a vast number of conceptual variations. Many other writers in the field of teacher education have put forward a retrospective view of reflection (Grant and Zeichner 1984; Shulman 1986; Clark and Peterson 1986; Munby and Russell 1990, among others). However, others such as Van Maden (1995:34) consider reflection as not only retrospective, but also prospective, and in the case of Schon (1983) reflection bound by action present (*reflection-in-action*).

Conway (2001:90) argued that the over-emphasis on retrospective rather than prospective aspects of reflection has had far reaching implications in terms of the relative advantage of the former over the latter. He further argued that this focus is based on the mistaken assumption that a retrospective stance is the only vehicle to examining one's knowledge and experience. Reflection, whether retrospective or prospective, should not be linked specifically to a time period but rather to the establishment of some critical distance so as to facilitate one's objective analysis of anticipated, current or past actions.

According to Schon, it is possible to reflect on one's action during actual practice. He contends that practitioners in addition to reflecting on their *knowing-in-practice*, also *reflect-in-action* (pg. 62). Schon believed this type of reflection may not be very rapid since it is bound by *action-present*. The latter he referred to as the zone of time in which the action can still make a difference to the situation. Hence, during this period, our thinking serves to re-shape what we are doing while we are doing it.

Schon suggested that *reflection-in-action* has a critical function since it questions the structure of 'knowing-in-action'. He viewed *reflection-in-action* as a means by which professional knowledge is put into play both in terms of problem setting and problem solving. Schon considered 'problem-setting' as a process in which, interactively we name the things to which we will attend and frame the context in which we will attend to them (pg. 40). The underlying tenet behind Schon's argument is that by thinking about our actions and reactions during practice, we can improve practice. Ghaye and Ghaye (1998) supported Schon's notion of *reflection-in-action*. They viewed reflection on practice as a natural process of making sense

of professional action. They argued that when we begin to realise that our existing stock of knowledge, (our knowledge-in-action), is inadequate in helping us work in a confident manner, *reflection-in-action* occurs. According to Smyth (1991:28), although we can and do reflect in action, we seldom reflect on our reflection-in-action.

Bright (1995:70) claimed that since most teachers do some form of reflection or another in the midst of their practice, the real issue is not between reflection and non-reflection but between efficient and inefficient reflection. Bright asserts that efficient reflection is *open*, involves genuine criticism and requires personal and professional integrity and honesty. On the contrary, inefficient reflection is *closed* and is influenced more by the need to defend and justify action rather than critically examining it in an objective manner. Bright argued that the purpose of inefficient reflection is defensive and it results in the failure to critically examine action and as such, it is self-fulfilling. The latter implies that although all practitioners might engage in reflection, there might be inefficiencies in the way they reflect.

2.5.2: The value of collaborative reflection

The notion of reflection as proposed by Schon (1983) appears rather plausible, but as contended by Convery (1998) it invites teachers to focus only on their immediate classroom performance. Ross (1992:179) argued that models of reflection as proposed by Schon (1983, 1987) rely heavily on notions of reflective thought as predominantly an individual act. Although Schon (1987) argued for a *reflective practicum* in which people learn by doing through interacting with someone who assumes the role of coach, he gives much more attention to individual aspects of reflection at the expense of alternative social aspects.

Moreover, during Schon's reference to social models of reflection, his argument tends to condone some hierarchical view of the process.

Freese (1999:904) appeared in agreement with a social dimension to reflection but her appreciation of such social contribution was in light of Schon's hierarchical model usually involving pre-service teachers and their mentors. Elliot (1989) recognised the dangers of hierarchical models of reflection in his contention that 'expert' intervention can be resisted and self-reflection can be inhibited in the presence of an authority figure. Blumberg (1980) and Rublin (1979) argued that there is evidence that teachers seek advice from their colleagues rather than from those in administrative or supervisory positions.

Ross (1992) argued that instead of individual reflection, teacher education should focus on the development of self-critical communities of teachers and the use of strategies that stimulate collaborative reflection and question posing. Convery (1998) held a radical view of the process, consequently ignoring the importance of the individual during reflection, in his notion that it is an activity that can only be developed in conducive, social and emotional circumstances. Edwards and Brunton (1993) suggested that reflection on practice must be more than a solitary activity if learning is to occur and as such dialogue is essential to the cycle of reflection on practice. Further, Clift et al. (1990) believed while reflective practice may be essential for every individual its improvement is as a collective collegial activity.

The above arguments are essential since group support during reflection encourages individuals to critically analyse each other's practice leading to 'co-reflection' and 'co-

construction' of teaching incidents and subsequently improving teaching and learning. I argue that *reflection* is better propagated in a comfortable, collegial and social atmosphere that is independent of hierarchical structures, since individual's deepest thoughts are enhanced through immersion in the experiences of their colleagues. Hence, the term *socially triggered reflection* seems fitting and may presumably act as an alternative to the concept of group reflection. One could perceive *socially triggered reflection* as the art of personalising the experiences of one's colleagues to assist in the retrieval of one's deepest thoughts in light of his/her own experiences.

Ghaye and Ghaye (1998:20) described *'reflective conversation'* as a special type of discourse that takes the form of questions and responses. This involves moving from private to public or from tacit and unconscious knowing to more conscious knowing. Zeichner and Liston (1996) believed teachers support and sustain each other's growth through continuous reflection. According to Pugach and Johnson (1990), the continuing support for a reflective disposition among teachers can be mediated and simultaneously enhanced by peers whose roles might be described as helping to stretch the limits of their colleagues' capabilities of reflection. Bright (1995:72) also supported the above notion in his assertion that observing and interpreting ones own action is often difficult particularly when we are the agents of the actions upon which we are attempting to reflect.

Reflection involves a continuous process of planning, accumulation, analysis, evaluation and making sense of information, hence it impacts on all aspects of the teaching process (Fig. 2.9). Schon (1983:32) considered the reflective process to be cyclical in character since it uncovers

new understanding of events and new discoveries that call for further reflection. The process spirals through four phases and therefore opportunities for growth and development exist at all stages.

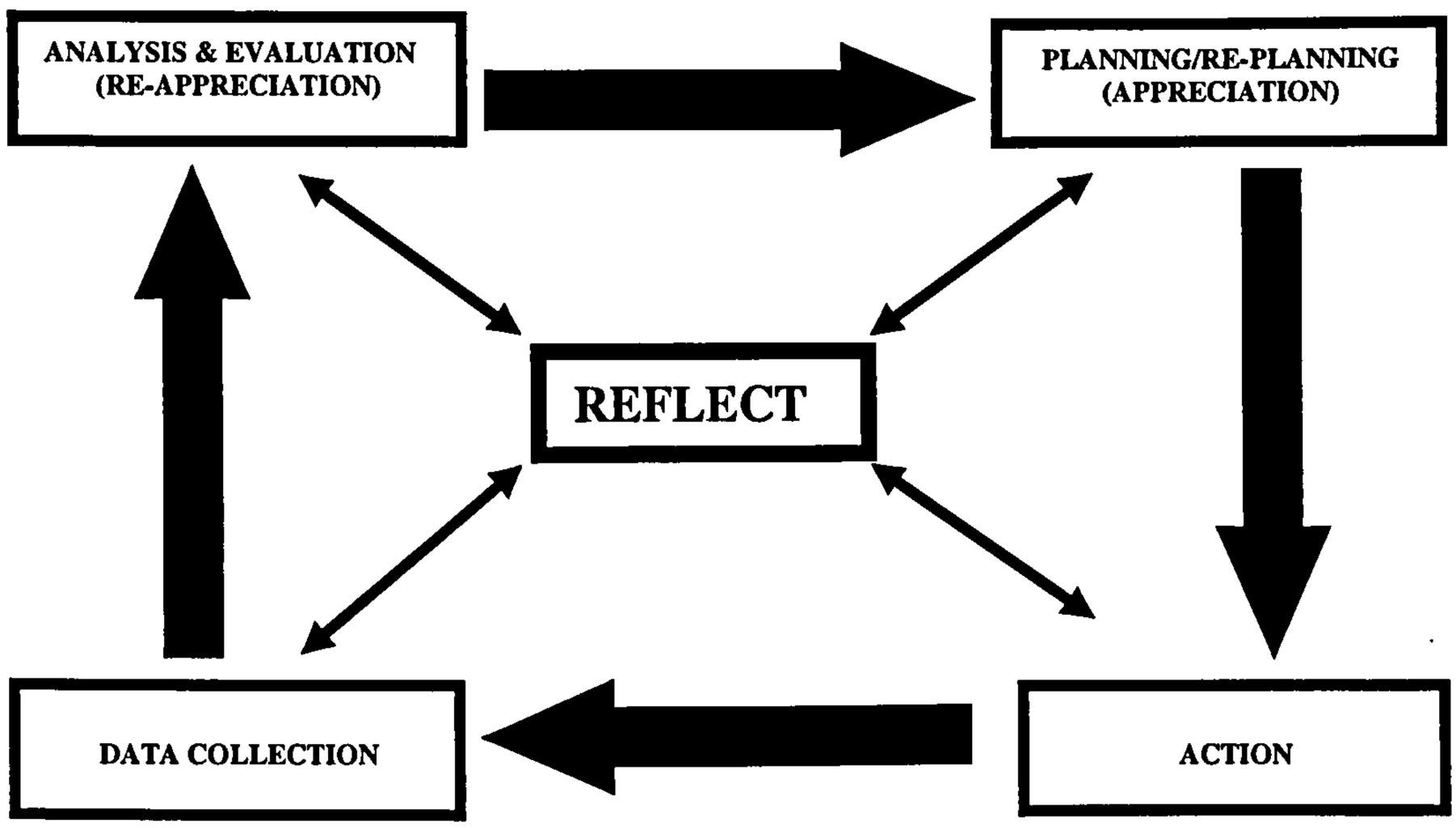

Fig 2.9: The continuous process of teacher reflection

2.5.3: Reflection and teacher development

Ghaye and Ghaye (1998) suggested that one of the fundamental purposes of reflection is to improve the quality of teaching and learning since improving teaching begins from a consideration of what we actually do in the classroom as teachers. They argued that reflection is essentially about developing teachers' self-knowledge and the ability to see through teaching situations and understand the meaning of what is happening in their classrooms (pg. 3). MacKinnon (1987:144) added to the latter argument in his assertion that the development of professional competence in teaching is related in part to the habit of reflecting on practice. Hence, reflection in this sense is marked by a willingness to examine teaching experience from a variety of perspectives and theoretical platforms.

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As suggested by Ghaye and Ghaye (1998), reflection should not entail support without challenge, nor should it be challenge without support since the latter can be demoralising. Bright (1995:72) asserted that the aim of reflection is to increase the level of competence relative to that which already exists, rather than raise it from a level of incompetence to competence. This view is essential because teachers often characterise innovative programmes, particularly those that appear demanding, as a method of eliminating inefficiency and incompetence on their part. Smylie and Conyers (1991) argued that we must recast in-service training programmes to reflect paradigm shifts from *deficit-based* to *competency-based* approaches in which teachers' knowledge, skills and experiences are considered assets.

Zeichner and Liston (1996:6) consider the following as attributes of a reflective teacher:

- *Examines frames and attempts to solve the dilemmas of classroom practice.*
- *Is aware of and questions the assumptions and values he/she brings to teaching*
- *Is attentive to the institutional and cultural context in which he/she teaches.*
- *Takes part in curriculum development and is involved in school change efforts.*
- *Takes responsibility for his/her own professional development.*

Reflection is essential to continuous teacher development since without reflection, practice becomes routine and teachers miss out the small but significant aspects of teaching that often make the difference to student learning. This notion is argued by Schon (1983) in his assertion that when practice becomes increasingly repetitive, and *knowing-in-practice* becomes increasingly tacit, the practitioner may *'overlearn'* what he knows. Hence, reflection may serve as a corrective to *overlearning* since through reflection one can surface and criticise such tacit

understandings that have grow up around repetitive practice and can make new sense of situations of uncertainty and uniqueness (Schon 1983). Ghaye and Ghaye (1998) contended that engaging in reflective processes is about admitting that practice can always be improved and as such reflection refuses to allow experience to become a liability.

2.5.4: Is there room for reflection amidst teachers' busy schedules?

Kincheloe (1991:12) argued that the modern teacher is seen as a plate juggler frantically running from plate to plate, keeping each one spinning atop each stick, unable to pause long enough to reflect on the purpose of the entire enterprise. The latter is particularly true in schools where teachers are already overburdened with administrative tasks. Most teachers are willing to improve practice but rarely receive the opportunity to do so since they are continually under pressure of job-related tasks. In this light, Schon's reflective practitioner model is advocated in an effort to minimise the difficulties that teachers may experience under practical job conditions.

The above does not mean that the adoption of a reflective stance is simple, since reflecting on practice is not a simple process, particularly for teachers who have been seasoned in repetitive traditional teaching practices. In practical settings continuous reflection on practice is much more difficult than may appear. This is particularly true of individuals who are already swamped with bureaucratic requirements during daily practice. Smyth (1991) believed teachers can and do seek opportunities to be reflective and to scrutinise their teaching when introduced to acceptable methods.

The idea of reflection should not be seen as a panacea for repairing all the ills of classroom practice. Wildman et al. (1990) identified the following problems of reflection:

- *Lack of time on the part of teachers.*
- *School administration may not always see the value of taking time out to discuss with other staff and reflect on practices.*
- *Reflection involves a degree of personal risks since it means that one begins to question what he/she is doing.*

According to Houston and Clift (1990:208), it would be naïve for anyone to assume that a few workshops at a school could make a reflective individual out of someone whose current practice consists of primarily mindless automatic actions. At the same token, we cannot always assume that teachers rarely think back on their teaching and attempt to improve upon their actions in subsequent lessons. Rueda and Garcia (1994) believed although changing teachers' paradigmatic belief system is neither simple nor short-term, if teachers are given the opportunity to reflect on their teaching practices, they not only get better at reflection but often change from traditional belief systems as well.

2.6: Exploring classroom learning

Learning is considered an enduring change in an individual that is not attributed to genetic inheritance, but rather to experience (Bigge 1971:1; Mazure 1990). Pollard (1997) believed learning should not be confused with the mere completion of classroom tasks as it is so often assumed. He defined learning as the process by which skills, attitudes, knowledge and

concepts are acquired, understood, applied and extended (pg. 118). Pollard viewed learning as partly a cognitive process, partly social and partly affective.

2.6.1: Behaviourist theory

Behaviourists contend that individuals learn by building up associates or *bonds* between their experience, their thinking and their behaviour. Ivan Pavlov pioneered behaviourist theories with his principle of conditioning. According to Pavlov, if a previously neutral stimulus is paired with an unconditional stimulus, it becomes conditioned and may prompt a response similar to that produced by the unconditioned stimulus. Pavlov's findings had marginal implications for classroom instruction but it inspired the work of researchers such as Thorndike (1911) and Skinner (1953). Thorndike (1911) extended the principle of conditioning with his theory of *'law of effect'* suggesting that the greater the satisfaction or discomfort, the greater the strengthening or weakening of a bond. Thorndike also established the *'law of exercise'*, with the contention that an act followed by a satisfactory change in the environment, is most likely to be repeated in similar situations. At the same token if such act is followed by an unsatisfactory change, the chances of repeating it decrease.

B. F. Skinner (1953) brought the latter theory to yet a higher level with the concept of *operant conditioning*, which claimed that consequences can be used to control the occurrences of behaviour. According to Skinner, behaviours are dependent on immediate consequences. Hence, pleasant consequences strengthen behaviour, while unpleasant consequences reduce the frequency of behaviour.

❖ *Implications of behaviourists notions*

Behaviourists' theories have profound implications for classroom instruction. The most direct influences of such theories are observable in aspects of classroom management and discipline. Pollard (1997) suggested that the influence of such theory could be seen through the high degree of adult control in the teaching/learning process (Fig 2.10), and a high level of coherence and linearity during the introduction of particular topics.

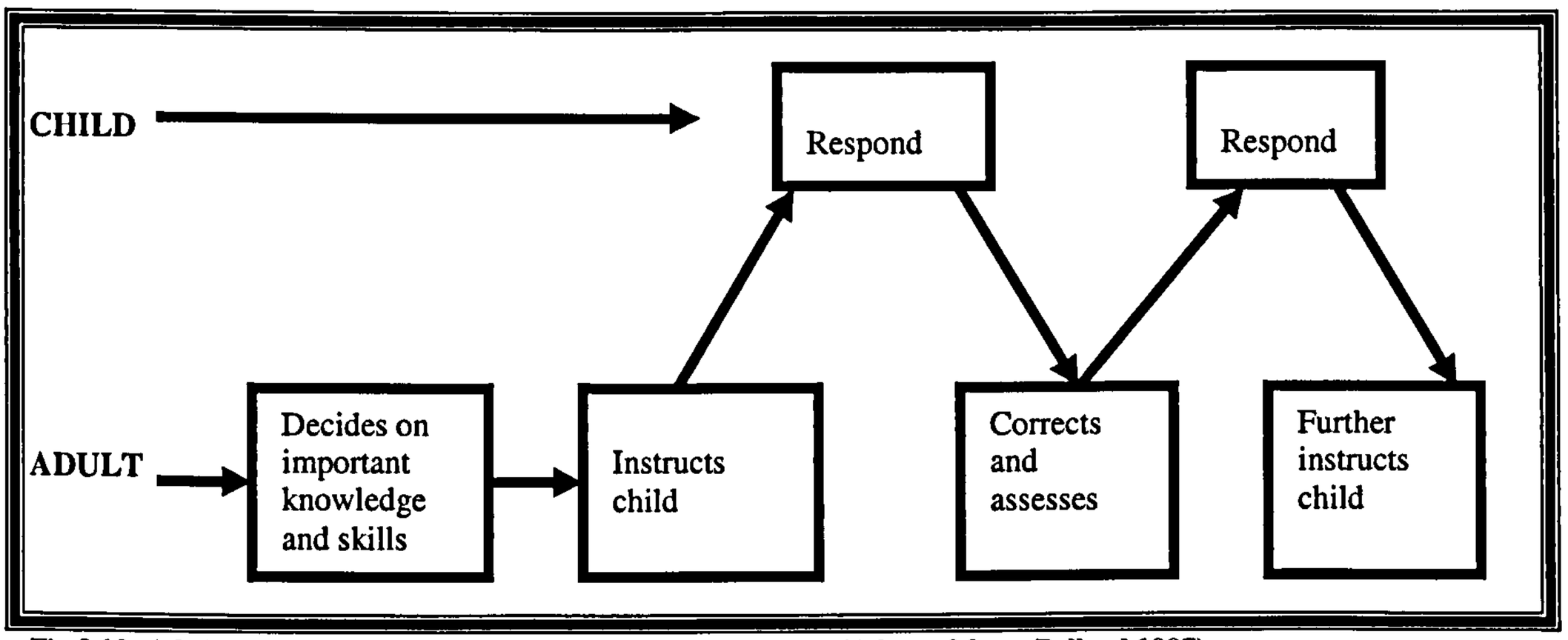

Fig 2.10: A behaviourist model of the teaching/learning process. (Adapted from Pollard 1997).

In addition, since behaviourists perceive education as maximising knowledge, this tradition casts the learner in a passive role, leaving the selection, pacing and evaluation of learning activities entirely up to the teacher. The tradition is reflected in the organisation of classrooms where large groups or the entire class are subject to the delivery of information. Further, the influence of these theories is seen through re-enforcement of desirable behaviours, elaborate systems of rewards and punishment and the use of drill and practice as well as rote learning.

Although, from a teacher's perspective, this approach appears to facilitate lesson delivery, there is difficulty in connecting with the existing understanding of students. Hence, this practice may lead to a reduced level of motivation and consequently poor student performance. Pollard (1997) noted that in the limited instances where learning occurs in such context, it tends to be superficial and fragmented since it is difficult for the teacher to pitch the lesson at an appropriate level for all learners.

2.6.2: Cognitive theory

The cognitive theory relies heavily on the developmental stages of individuals. Piaget suggested that cognitive development and learning occur in developmental stages and as such the nature and structure of intelligence changes significantly over time. He argued that the stages of cognitive growth are distinctly different and the content of each stage is pivotal in determining the way we understand and make sense of our learning experiences. Piaget (1960) established four stages of cognitive growth namely, the sensory-motor, pre-operational, concrete operational and formal operational. He believed that each of these stages coincides with the level of developmental age in the individual and as such development precedes learning. The theory is also structured on an information-processing-model. The latter is based on research on human memory and contends that the human brain is capable of efficient processing and storage of information. The model recognises the importance of practice and organisation of information in aiding memory.

Cognitive theory has been criticised mainly because it views children's development in sequential, structured stages that may lead to an underestimation of their real capacities. According to Fisher (1990), while these stages exist, they occur in an irregular pattern and as

such there is no particular pathway of intellectual development along which a child travels. Hence, for each child, the pattern of intellectual development is uniquely based on the environment and the level of instruction received. In addition, the theory has also been criticised as aiding practices where teachers classify and compare children. According to Wadsworth (1996), such theory over emphasises the individual at the expense of the social context in which learning occurs.

❖ *Implications of cognitive theory*

The cognitive theory encourages lessons with sequential, well-organised stages and graded levels of difficulty. It strongly advocates the recognition and utilisation of students' pre-requisite or previous knowledge before a topic is introduced. The theory also implies that activity produces cognitive growth and hence, the development of the brainpower is not fixed at birth but rather is a function of appropriate activities during a particular developmental stage (Sprinthall et al. 1994). Further, the information-processing model emphasises the use of techniques to aid the storage and retrieval of information.

2.6.3: Constructivism

Constructivists argue that knowledge is created by the learner, hence dismissing behaviourists' notions of the teacher as dispenser of information. They believe the teacher's role is that of facilitator, teaching in ways that make information meaningful and relevant to students. The latter is often achieved by allowing students opportunities to discover or apply ideas themselves, and by teaching them to be aware of, and to constantly use their own strategies for learning. Constructivists believe individuals learn through an interaction between thought and experience and through a sequential development of more complex cognitive structures.

According to Von Glassersfeld (1989), this theory assumes that knowledge is not passively received but actively built up by the cognising subject. Hence, the central argument in the constructivist theory is that the learner must discover and transform complex information if he/she is to make his/her own (Brooks 1990).

❖ *Implications of constructivists theories*

Constructivists' theories have profound implications for classroom instruction. As opposed to behaviourists' theories, they emphasise the active role of the learner in his/her own learning. Hence, there is emphasis on a varied and stimulating classroom environment and the use of practical apparatus and challenging experiences. In practice, these theories cast the learner in an active role, leaving much of the selection, pacing and evaluation of learning activities open to negotiation (Fig. 2.11).

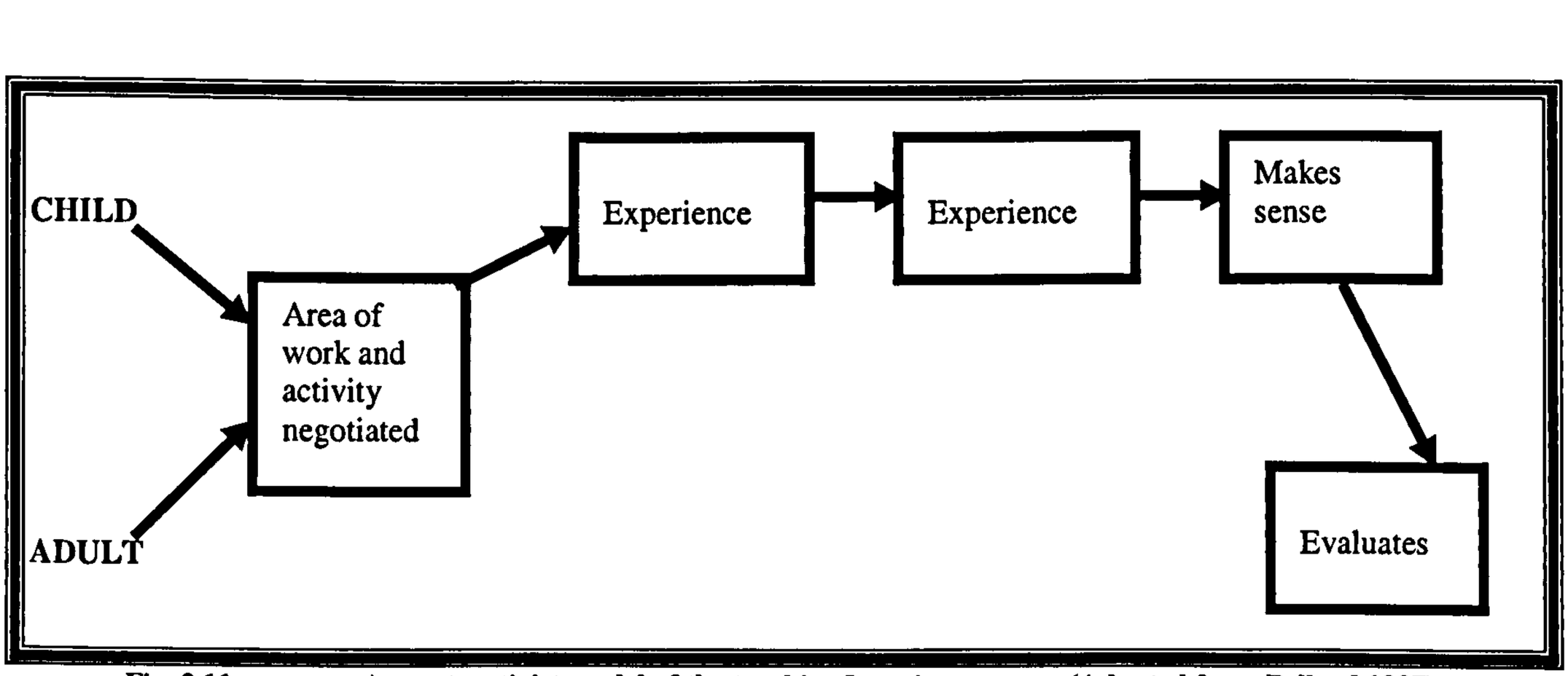

Fig. 2.11: A constructivist model of the teaching/learning process. (Adapted from Pollard 1997).

2.6.4: Social Constructivism

This theory is an extension of the constructivist model. However, it strongly emphasises the importance of the social context in learning. The social constructivist approach comprises

three integral components. Firstly, there is the notion that learning is a social phenomenon and therefore it is human nature to acquire capabilities with the assistance of other human beings. Secondly, it argues that language comes before thought. Thus, through the use of words, a child is able to shape his/her thoughts and internalise concepts. The third key idea is that of *metacognition* or the art of thinking of ones thought patterns. The reasoning behind such concept is that if children are introduced to the language of thought, one can get them to think more about their own thinking. According to Flavell (1976), metacognition involves one's knowledge concerning his/her own cognitive processes and products or anything related to them. Joyce and Weil (1996:51) contended that the central idea of metacognition is to help think about the nature of learning and to develop conscious control over the tool for learning.

The underlying argument of the social constructivist theory is the belief that learning mainly occurs when children are working within their *Zone of Proximal Development.* Vygotsky (1978) defined the *Zone of Proximal Development,* (ZPD) as the distance between the developmental level of a child as determined by independent problem solving, and the level of potential development as determined through problem-solving under adult guidance or in collaboration with more capable peers. Vygotsky argued the *Zone of Proximal Development* lies as much outside the individual, in the skills, ideas, concepts and strategies located in the social plane that he or his peers create, as it does in his own mind. He believed any function in a child's development occur twice or on two planes. Firstly, it occurs on the social plane and then on the psychological plane (pg. 163). The preceding contention relies on the assumption that children possess in addition to a set of completed skills and strategies, a set of half-formed or potential strategies that can be revealed by the influences of an adult or a more capable peer.

❖ *Implications of social constructivists theories*

One principal implication of the social constructivist theory is that students should be allowed to take responsibility for their own learning. In addition, social constructivism implies that social interaction and peer support are essential attributes to effective learning. This can be seen in an increase in the frequency of small group activities and challenging lessons. In addition, there is a shift in teachers' roles from that of instructor or dispenser of information to that of facilitator/mediator, where students are given the necessary scaffolding to enable each child to work within his/her ZPD (Fig 2.12).

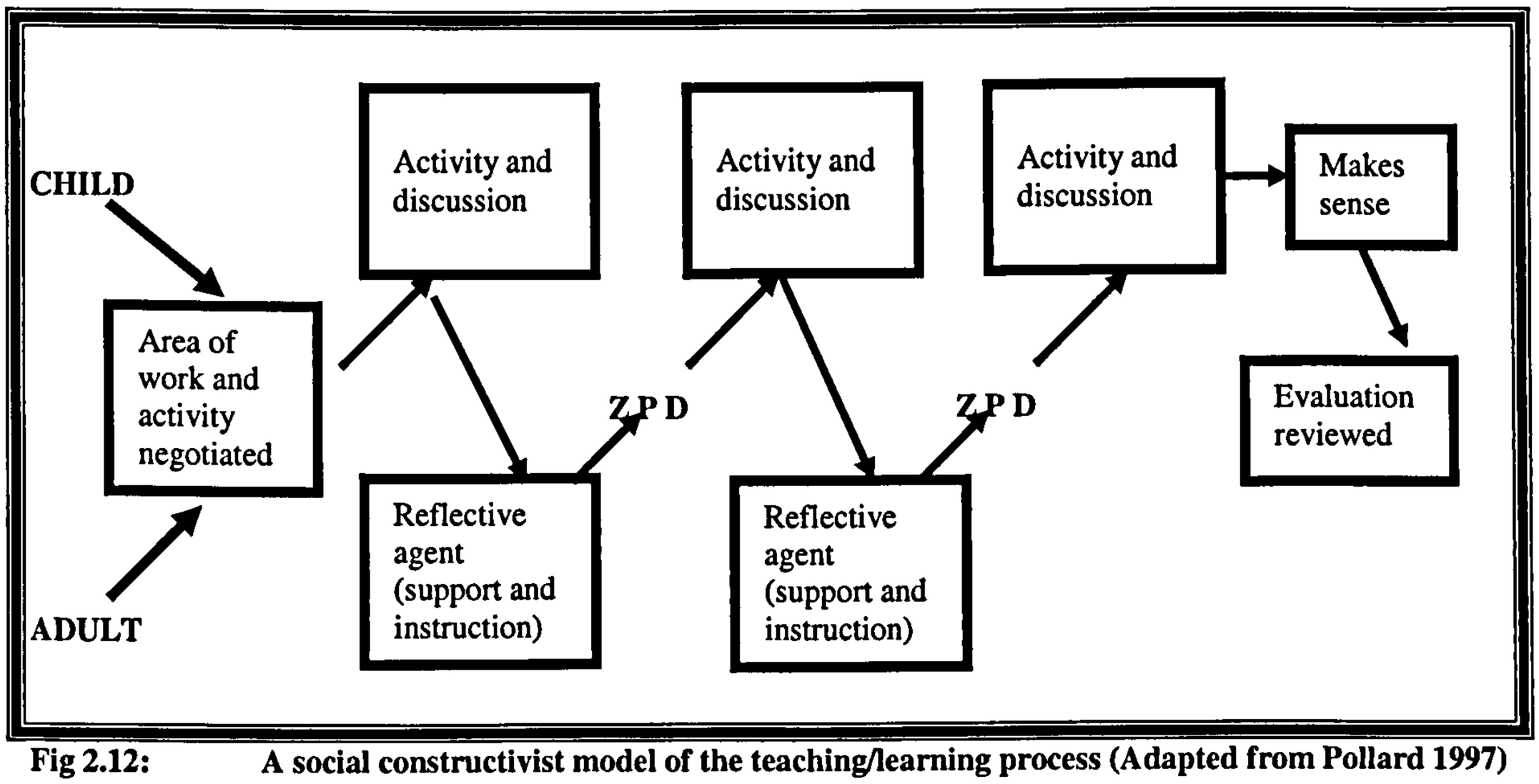

Fig 2.12: A social constructivist model of the teaching/learning process (Adapted from Pollard 1997)

One key idea derived from Vygotsky's work is that of *scaffolding*. Wood (1976) equated scaffolding with *contingent teaching*, which he defined as the teacher's ability to provide help at discretionary proportions. In practice, this concept involves providing just the right amount of assistance and a reduction or subsequent increase of such assistance as considered necessary by a more experienced peer or by the teacher. As stated by Greenfield (1984), during the

process, the task is not simplified but rather the role of the learner is simplified through graduated intervention.

Vygotsky was of the view that cognitive development occurs through mediation. As such, the most effective learning experiences are not available directly to the learner from interaction with his/ her environment but must be mediated by an adult or older child. Feuerstein *et al.* (1980) added to Vygotsky's concept of mediation in his view that the teacher is too far away from where the adolescent is to know successfully what to offer. This means that the phases of a lesson must be managed in such a way that each child receives a significant opportunity for mediation. It must be noted rather forcefully that the above argument casts doubt on the notion that improving students' performance in school is just a matter of providing them with knowledge and content, which is more commonly known in educational terms as *good instruction.*

2.7: Mathematics teaching and learning

The research study falls within the framework of infusing thinking skills in Mathematics education. In the Dominican context, the importance of Mathematics education is made explicit in the curriculum by the huge proportion of time devoted to the subject and its exclusive status as a compulsory subject in all primary and secondary educational institutions. Orton and Frobisher (1996) argued that although there is no evidence that learning Mathematics improves thinking and problem solving, there is much attention given to student competence in Mathematics at the end of their schooling. Such attention is partly due to the

emphasis given to this area in the job market and invalidated claims that it is equated with clear thinking and the ability to solve problems.

2.7.1: Approaches to the teaching of Mathematics

Mathematics teaching should entail enjoyable activities and should be child-centred and challenging. Teachers should create a classroom atmosphere where there is the most minimal chance of failure and as such, all students should have a chance of making some progress during the lesson and to extend their thinking. This means open-ended questions, although rarely utilised in typical Mathematics instruction, should be the predominant form of soliciting information from students.

Another essential area in the teaching of Mathematics is the need to make connections among various topics. Heibert and Carpenter (1992) suggested that making connection among topics is pivotal to the development of Mathematics understanding. They however question whether teachers should make these connections explicit or whether they should allow students to make these connections themselves.

2.7.2: Teachers and the teaching of Mathematics

The National Council of Teachers of Mathematics (NCTM 1991) argued that Mathematics need to be taught as a dynamic tool for thought and not just as a set of operations to be learnt. It encouraged teachers to give students' some discretion in how they approach Mathematical problems and to use a variety of approaches to Mathematical tasks. Thompson (1984) believed that the question of how to integrate teachers' knowledge of Mathematics into instructional

practices and what roles their conceptions of Mathematics might play in teaching, have largely been ignored. He believed teachers develop knowledge of the subject matter that is characteristic of their instructional practices.

According to Thompson (1984) and Boaler (1997), there is strong reason to believe that in the teaching of Mathematics the conceptions of teachers about the subject matter play an important role in affecting their effectiveness as the primary mediators between the subject and the learners. As stated by Askew et al. (1997), among other qualities, highly effective teachers of Mathematics believe that being numerate requires having a rich network of connections between different Mathematical ideas and being able to select and use strategies that are both efficient and effective. Ernest (1998:117) believed that the key educational focus in Mathematics teaching is the process of doing Mathematics and not the answer obtained.

2.7.3: Mathematics learning

The importance of the social structure for learning cannot be overemphasised. In the Mathematics classroom, collaboration among students greatly enhances their understanding of Mathematical concepts. Students should engage in Mathematical activities with confidence and enthusiasm, and teachers should use assessment that focuses on understanding rather than on correct answers (National Council of Teachers of Mathematics 1991). Resnick (1987:13) argued there is substantial evidence to suggest that children's difficulty in the learning of Mathematics derive in a large part from their failure to recognise and apply the relations between formal rules taught in school and their own independently developed Mathematical intuitions.

Ball (1993) advocated an approach to the learning of Mathematics where students engage in activities that will assist them to construct Mathematical concepts. This is more effectively done with students working together and sharing ideas in the Mathematics classroom. Noss (1994) regarded the encouragement of flexibility and adaptability as the most important roles for Mathematics education in the future. This serves as a necessary response to the development of technologies of various kinds and the changing nature of the job market.

2.8: Developing thinking skills in the classroom

The rapid pace of change world-wide coupled with repeated calls to raise standards of attainment in schools, have resulted in a dire need for alternative approaches to teaching. Mulcahy et al. (1991) suggested that dynamic changes in society demand the teaching of skills that are considered essential in acquiring and using information. According to Nickerson et al. (1985), the need for greater educational emphasis on thinking skills is very substantial and there is evidence of an increasing awareness by educators of that need. Nickerson (1991) concedes,

> *'...traditional schooling is not having the positive impact on the thinking skills ability of students that we would have hoped and might have expected it would have'* (p. 4).

Individuals do not become *good* thinkers by completing conventional subject matter courses as have been the case with traditional schooling (National Commission on Excellence in Education 1983). Hence, in order to make a positive impact on students' learning and to assist students to flourish in a rapidly changing society, alternative approaches to the acquisition of knowledge and skills are necessary.

2.8.1: An exploration of the concept of thinking

De Bono (1976) considered thinking as the deliberate exploration of experience. Pace (1991) viewed thinking as the mental processes and skills that we use to shape our life. Nickerson (1991) added thinking is,

> *'the kind of cognitive activity in which we engage when we attempt to evaluate conflicting evidence on a controversial issue in order to arrive at a reasonable conclusion'* (pg. 3).

According to Nisbet (1991), admitting that we can teach thinking is perhaps pretentious and as such it is probably more acceptable to express our aims as that of *'accelerating cognitive development'*, although he believes that such may still be an unproven claim. Cognitive acceleration is considered a proactive exercise since it is essentially an intervention aimed at enhancing learning and independent thinking (Adey and Shayer 1994). Hence, it is often thought of as a valuable extension to the concept of thinking skills development.

Psychologically, the concept draws on Piagetian, neo Piagetian and Vygotskian principles. According to Piaget (1960), between the ages of twelve and eighteen most individuals go through qualitative change. During their early teenage years, children use concrete operational thinking, which then changes to formal operational thought patterns in later stages of development. An essential characteristic of concrete operations is the ability to describe situations but not necessarily explain them. Formal operational thought, on the other hand, allows students to generate ideas about events already described through concrete operations and then test how well these ideas connect the events (Adhami *et al.* 1998b).

2.8.2: Can thinking skills be thought and learnt?

There has been much educational debate related to the practicality, utility and value of teaching thinking skills. Maclure (1991) argued that by raising the question of whether thinking skills can be taught, one already assumes that it can be taught and further implies that certain types of teaching can improve particular types of thinking. Costa (1992) was of the view that thinking as a skill can be taught but for this to occur, teachers need to treat students as *thinkers* and not simply as *learners*. According to Borkowski et al. (1990), learning is enhanced when students develop a repertoire of strategies for thinking and monitoring their learning process. de Bono (1991:5) argued that education is both inward-looking and complacent since it rarely understands what is meant by thinking and is confused as to how thinking can actually be taught. According to de Bono, since thinking is such a fundamental aim of education, most education systems make a false claim they are already teaching thinking skills (p. 3). He considered the following fallacies in many education systems (p. 4):

- *Intelligence is the same as thinking skills*
- *Teaching knowledge is sufficient*
- *Thinking skills are taught within every subject*

Maclure (1991) objected to de Bono's claims in his contention that refining and sharpening the powers of thought has always been the prime objective of formal education. He argued since education is about acquiring the ability to collect, manipulate and apply information for the purpose of understanding and mastering a given subject, then it is inevitably about thinking. Burden (1998:1) indicated the question of whether thinking skills should be taught in schools is itself absurd since thinking is an integral component of all learning and not something that can be separated from other human activities.

Baumfeld (1995) identified the following principles shared by thinking skills programmes:

- *They change the learner*
- *They make pupils transfer their learning*
- *They promote learning with others*
- *They encourage pupils to regulate their behaviour*
- *They challenge the learner*
- *They are carefully structured*
- *They help develop core concepts and skills*
- *They make students think about thinking*

Burden (1998) asserted that since thinking, like other generic activities, can be performed at various levels, then it should be possible to learn how to think more effectively and even to be taught to do so. According to Coles and Robinson (1989:18), if the aim of education is the promotion of children's thinking, then knowledge acquisition has to assume a subsidiary status and thinking must not be taught only as a sub-component of other activities. Hence, educational institutions should devote more attention to teaching students to learn and think for themselves, while simultaneously being less focused on content and the provision of a body of knowledge.

There is much scepticism about the teaching of thinking. Coles and Robinson (1989) argued that such scepticism might be justified due to the lack of objective evidence and validation that is often associated with thinking skills programmes. According to the authors, many argue that the statement '*it is possible to teach thinking*' is an empirical one and as such it should be supported by strong and objective empirical evidence, which is often limited. However, Nickerson et al. (1985:34) do not share this view since they are convinced that enough

evaluative data has been obtained to suggest that the teaching of thinking yields positive results in students' performance.

One could argue that inasmuch as the teaching of thinking is a humanistic endeavour, it represents an elevation of the individual's capacity and as such requires minimal justification. At the same token, one must concede that implementing intervention approaches without adequate appraisal, review and evaluation might disguise some fundamental flaws in the process. Dewey (1916:179) admitted that no one doubts theoretically the importance of fostering good habits of thinking in schools. However, he believed there is not adequate recognition that schools can and need to develop pupils' ability to think. Coles and Robinson (1989:22) conceded that the problem is not whether we can teach thinking since evidence has suggested that we can. Rather, the problem remains whether we are willing to make the pedagogical changes necessary to do so, and if we are, which changes might be most effective.

Although the teaching of thinking skills may be considered advantageous in many ways, one must note that the decisions to encourage students to think for themselves should be approached with cautious optimism since on occasions teachers, and even students themselves, may not want to follow such routes. The latter argument is reiterated in the following excerpt as depicted from the experiences of one teacher in attempting to teach thinking skills.

> *'We see what this is all about now' said one student. 'You are trying to get us to think and learn for ourselves'. 'Yes, yes,' replied the teacher, heartened by this long delayed breakthrough, 'that's it exactly'. 'Well, said the student, we don't want to do that!'*

White (1988:1)

2.8.3: Arguments for the teaching of thinking skills

There are several reasons why the teaching of thinking should be advocated in schools. Firstly, the rationale for teaching thinking has been grounded on the challenges exerted by rapid changes in society and the ever-changing world of work. One essential argument in support of the teaching of thinking skills is that if students are to be prepared for a world beyond school, then they need to be taught explicitly how to think. Secondly, thinking is no longer equated with retaining and reproducing a body of knowledge. In addition, since knowledge is actively created rather than transmitted, meaning is jointly constructed and heavily influenced by context (Mercer 1992). Further, there is growing evidence from various studies that the teaching of thinking enhances students' classroom performance (Whimbey 1985; Bransford et al. 1986; Hudgins and Edelman 1986; Haller et al. 1988; Adey and Shayer 1993; Adhami et al. 1998a; Burden and Nicholes 2000, among others).

Rudduck (1986:6) argued that teachers and pupils often conspire in perpetuating a false security that manifests itself in reliance on right answers and on a view of the expert as one who knows rather than as one who uses knowledge to refocus doubt. She was of the view that teachers often oversimplify the complexities of living and learning and seek to protect their pupils from uncertainty by holding out intellectual safety nets. As stated by Rudduck (1986), many pupils find it hard to conceive of questioning adults after years of regarding knowledge as something that lies between the covers of an official text book or exists in the teacher's mind. Hence, pupils rarely adopt a sense of critical thinking and they lack the questioning attitude that is required for efficiently exploring classroom issues. According to Williams and Burden (1998:189), if learning to think is to be a cornerstone of education, then in order for the

curriculum to have some coherence, the subject areas need to embrace the philosophy that sees thinking as central. They believed cognitive development should be seen as a broader holistic approach to education where connections are constantly made from aspects of the curriculum to issues in everyday life.

2.8.4: Models for teaching thinking skills

There are various models for the teaching of thinking skills. However, they all have a principal purpose, which is maximising the transfer of learning. The two main models of teaching thinking are the *skills (explicit*, or *programme)* model and the *infusion* model.

2.8.4.1: Skills model

The *skills* model is based on the explicit teaching of component skills in thinking that are practised in special courses without being attached to any particular subject area. According to Maclure (1991), advocates of this model argue that it is possible to teach thinking skills explicitly through activities and exercises. Hence, thinking becomes a curriculum subject in its own right.

Burden (1998:2), in a well-presented case for the skills model, argued that if something is worth teaching, then it should be afforded its own curriculum space. However, Coles and Robinson (1989:10) argued that while it is obvious that teaching thinking is an important educational objective, skills-based programmes still need to offer reasons for their inclusion on the school's curriculum. According to Nisbet (1990) skill based programmes are disadvantageous in the sense that they appear to treat thinking as an *'add on'* element.

2.8.4.2: Infusion model

The *infusion model* encourages the embedding of thinking skills into subject disciplines in the form of a thinking curriculum. Through this approach, effective thinking becomes the primary aim, but a deliberate effort is made to achieve this through the reconstruction of the content and approaches to teaching traditional subjects (Burden 1998:51). Nisbet (1991) advocated an infusion approach in his contention that the pedagogical process should involve the social construction of thought that is centred upon key concepts, skills and knowledge within various curriculum areas. Advocates of the infusion model argue that thinking cannot be separated from its context and that infusion facilitates transfer.

Resnick (1987) identified the following advantages of the infusion model:

- *It provides a natural knowledge base in which to practice and develop thinking skills*
- *It provides criteria for what constitute good thinking within that subject discipline*
- *It ensures that something worthwhile has been learnt in the event that universal transfer is unattainable*

A point of caution is that the approach demands radical changes in the presentation of materials, classroom management skills and in the responses demanded from students.

There is no perfect model for every situation or context (Maclure 1991; Baron and Sternberg 1987). Hence, one only needs to decide which works best in a given setting. Burden and Williams (1997) added that there is no reason why the approaches should be seen as mutually contradictory. Costa (1992) supported the use of both models in the teaching of thinking skills. While he contended that curriculum content must be selected only for its contribution to the thinking process, he also believed that in order for students to become better thinkers then they must be taught explicitly how to do so.

2.8.5: Evaluating and assessing thinking skills strategies

Adey and Shayer (1994) concluded that if we are to investigate the possibilities of intervention in cognitive development, then it is necessary to characterise in detail the nature of the development, how it may be monitored and how its enhancement could be recognised. Nisbet (1990) added that if people are to be persuaded to take thinking skill programmes seriously, then there must be strong evidence that it can be done effectively. Such proof however, is not always assured since it is difficult to determine what is to be taken as evidence of success. Burden and Nicholes (2000) argued that the evaluation of thinking skills approaches poses numerous difficulties. It may often be considered subjective since in most cases thinking skills approaches produce no quantifiable results.

Nisbet (1990) believed there are problems with the evaluation of thinking skills programmes since it is difficult to readily distinguish between the merits of a programme and the methods adopted in its implementation. Secondly, he argued that evaluation studies are short-term and cannot assess long-term impact. A central debate in assessing students' acquisition of thinking skills is the use of innovative and contemporary approaches to teaching and learning coupled with traditional assessment frameworks. Traditional tests are often considered invalid methods of evaluating thinking skills approaches since, according to Nickerson et al. (1985), they often compromise reliable judgements of the programme's effectiveness. Wiggins (1989) argued that traditional tests do not reflect the objectives of thinking skills programmes because they focus on a body of content as opposed to the development of cognitive processes.

An acceptable alternative to the use of traditional tests may be the use of *process* oriented as opposed to *product*-oriented assessment. According to Andrews *et al.* (1991), the use of process oriented assessment places more emphasis on the procedures that a student uses in addressing particular task and therefore reveals valuable information for further intervention. Wiggins (1989) believed authentic evaluation is most accurate and equitable when it entails dialogue so that the person tested can ask for clarification of questions and can explain his/her answers.

Pace (1991) held the view that students must be allowed to self-evaluate their own thinking strategies and hence they actively contribute towards the assessment of learning outcomes. Although process oriented approaches are encouraging solutions to the problems of traditional tests, one still faces the issue of lack of objectivity since such approaches may be at their best rather subjective. However, it could be argued that inasmuch as this assessment framework treats every child based on his/her unique learning experiences, the potential advantages in terms of effective diagnosis, efficient intervention and subsequently improved learning, outweighs potential limitations.

2.8.6: Argument for traditional conceptions of teaching and learning

One might quite rightly ask, *why not continue with traditional conceptions of teaching and learning?* It would be unfair not to recognise such conceptions and blindly propose only contemporary teaching approaches. In the same vein it, must be said that there has not been much recent literature on an advocating such traditional conceptions. One might argue that this is probably due to the fact that such traditions had been thoroughly explored in past decades

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and as such there need not be further publications. Whatever, the reason for lack of recent publications on traditional conceptions, they have made a significant impact on teaching and learning in general. Behaviourists' models have been reputed for being teacher oriented but they appear to facilitate lesson delivery and enhance classroom management from a teachers' perspective. These traditional theories also ensure that lessons are focused and as such they reduce the level of time wastage in the classroom, though often at the expense of deep learning.

2.9: Cognitive Acceleration in Mathematics Education

Cognitive Acceleration in Mathematics Education (*CAME*) involves *infusing* thinking skills approaches in the Mathematics context. According to Adhami et al. (1997), the approach utilises cognitive stimulation as a means of aiding students to organise conceptual strands in Mathematics, rather than a dependence on the use of procedures and algorithms. Such cognitive stimulation is intended to raise the thinking capacity of students with lasting effects that create a stable basis for higher achievement in later school years (Adhami et al. (1997). *CAME* aims to contribute to teachers' professional development by grounding practice on research and theory.

2.9.1: The origin of CAME

CAME was developed based on the successes of an earlier intervention programme that was embedded in Science Education. Cognitive Acceleration in Science Education (CASE) was a research project investigating the possibility of raising the general level of thinking in adolescent students within the context of normal mixed-ability schools (Adey 1991:80). CASE

was grounded on the Piagetian model of levels of cognitive development and aimed to enhance formal operational thought in students.

2.9.2: Theories underpinning *CAME*

CAME draws on three major theoretical sources namely, research on levels of achievement in Mathematics, Piagetian and neo-Piagetian theories on levels of thinking and Vygotskian social constructivist theory. These three sources have been integrated for the provision of a theoretical base for cognitive intervention and classroom interaction.

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2.9.3: Pre-requisites to the implementation of CAME in classrooms

There are three critical steps that must be assured before CAME is implemented in classrooms (Adhami *et al.* 1997). Firstly, teachers must be convinced that there is a problem of under achievement at the upper secondary level that is due to inadequate challenge at the lower secondary level. Secondly, Mathematics teachers must recognise the difference between the agenda for *Thinking Maths* lessons and that of good teaching in the same topic. This would mean that instead of planning a lesson around a major learning point hopefully for all pupils, the teacher has to look at the same agenda in a developmental way such that many different levels of achievement may be realised (Adhami *et al.* 1997). Thirdly, according to Adhami et al., teachers after having gained ownership of the lessons will approach the rest of the Mathematics curriculum with a fresh perspective.

2.9.4: *Thinking Maths* lessons

The *CAME* intervention programme is made up of thirty (30) *Thinking Maths* lessons infused in the area of Mathematics education. These are intended to challenge students with focus on thinking, reasoning and the sharing of ideas rather than on knowledge. The latter is done through a structured exploration of major concepts of Mathematics in the main topic areas (Adhami *et al.* 1999). Adhami *et al.* (1998a) suggested that one of the key features of *Thinking Maths* lessons is that the challenges are not *'closed'* but they remain *'open'* ended with the key focus on Mathematical strands *(Appendix E).* Hence, the teacher's role becomes much more explicit in terms of *mediating* or *facilitating* as opposed to *directing* the class activity. *Thinking Maths* lessons are not substitutes but rather represent additions to students' normal Mathematical experiences (Adhami *et al.* 1998b).

2.9.5: Advantages of *CAME*

2.9.5.1: Benefits to students

The approach has not only proven to enhance students' social interaction and reasoning skills but also their cognitive development (Adhami *et al.* 1998b). It assists pupils in engaging in problem solving with an open-mind, drawing on critical analysis and evaluation skills more readily than typical instruction. *'CAME'* provides a non-threatening classroom atmosphere where the ideas of all students are equally valued and since emphasis placed on divergent thought, students develop a higher level of confidence. In addition to the above, there is more collaborative learning during such lessons and a subsequent increase in motivation since all students are given the opportunity to contribute. Further, the thought patterns developed during *CAME* lessons can be transferred to other subject areas and such improved skills can be

utilised across the curriculum. Hence, students become less reliant on the teacher as a source of information and move towards greater personal Mathematical judgement and autonomy.

2.9.5.2: Benefits to teachers

CAME is also beneficial to the professional development of teachers since it assists in teacher reflection, which consequently leads to improvements in their professional practice. Despite the fact that in past studies teachers have considered the approach to be threatening (Blaize 2000), after adequate practice teachers are more inclined to open up their classroom to team teaching.

2.9.6: Limitations of *CAME*

Like all educational innovations, *CAME* also has its limitations. The approach may be limited in that the lessons can be time consuming and require a high level of classroom management at all phases of implementation. In addition, since the approach has not been placed under rigorous scientific analysis, it is possible that the positive results of the approach may be influenced by other factors such as the size and nature of the class, the enthusiasm of the school staff, the internal and external environment, the frequency of the programme input and the nature of its evaluation.

2.9.7: Conclusion

One must re-iterate the importance of developing thinking skills in students so as to prepare them for the complex world of work. The role of the classroom teacher is paramount in the development of such skills. Costa (1991) claimed that intelligent behaviour develops within a

school environment where there is faith that children can think, where thinking as a goal is nurtured and where there is a stimulating environment that provides ample opportunities to solve problems. Hence, one might argue that teaching thinking is not only about 'answering the questions' but also about 'questioning the answers'.

As contended by Fisher (1990), teaching for thinking begins with valuing students' ideas and as such it aims for a transformational mode of learning. It acknowledges the fact that children do not come to the learning environment like 'empty vessels waiting to be filled up' nor as 'fires to be lit'. Hence, if the goal of education is to produce individuals who possess the ability to learn independently, then there is the need to explicitly develop thinking skills in students in order to foster such autonomy.

Thinking skills approaches provide a classroom atmosphere where active thinking and reasoning are considered the norm. They also allow students to build on their knowledge base by structuring their knowledge around that of their peers through classroom discussion. Hence, the goal of improving thinking in the classroom should be limitless. As stated Glatthorn and Baron (1991), our goal as educators is to foster the development of the '*good thinker*' attribute while simultaneously helping students understand the limitations of contrary dispositions and behaviours.

CHAPTER 3

METHODOLOGY

3.0: Purpose of the study

The research involved the implementation of a cognitive intervention programme [*Cognitive Acceleration in Mathematics Education* (***CAME***)] at three secondary schools in Dominica in order to determine:

- *The extent to which it contributed to the professional development of teachers as it relates to their ability to reflect on practice.*
- *The degree of change in teachers' beliefs and/or practices as a result of the innovation.*

3.1: Research design

The research employed *case study* utilising *multiple embedded cases.* The *multiple-embedded* design involved the use of multiple units of enquiry within larger cases (Yin 1989). Hence, in the research study, there were three major cases [as reflected by the *three* schools under study] and nineteen smaller cases nested within these major cases [as reflected by a total of *nineteen* Mathematics teachers at the three schools].

3.1.1: Research question and sub questions:

- ***Research question:***

How does the teaching of thinking skills influence beliefs and practices of secondary teachers in the Dominican context?

- **Sub-questions:**
  - *How does the teaching of thinking impact on traditional beliefs and practices?*
  - *What is the relationship between teachers' beliefs and practices on teaching of thinking?*
  - *How can teacher reflection influence their perceptions and practices?*
  - *How does the teaching of thinking impact on staff collaboration?*

3.2: Case study

Yin (1981) described a case study as an empirical inquiry that uses multiple sources of evidence to investigate a contemporary phenomenon within its real life context, when the boundaries between phenomenon and context are not clearly evident. Yin believed a case study is different from an experiment since experiments deliberately divorce the phenomenon from the context so that attention can only be placed on a few variables within that context. According to Robson (2002:80), the case study is not a flawed experimental design but rather it is a fundamentally different research strategy with its own designs. Case studies are different from surveys in the sense that surveys are extremely limited in their ability to investigate context since survey designs limit the number of variables to be analysed and consequently the number of questions that can be asked.

3.2.1: Advantages of case study

The case study allows the researcher to concentrate on a specific instance or situation in great depth during a limited time scale and to identify, or attempt to identify the various interactive processes at work (Bell 1993). According to Patton (1990:54), cases are particularly essential when the evaluation aims to capture individual differences or unique variations from one

programme setting to another or from one programme experience to another. A further advantage of the case study is that it allows the researcher to use a variety of sources, data and research methods as part of the investigation. This in turn facilitates the validation of data through triangulation.

3.2.2: Limitations of case study

One of the major limitations of the case study is that generalisation of findings is not usually possible. Furthermore, because the researcher is almost always involved in the settings for the study, this may lead to *'the observer effect'*. Hence, those under investigation might behave differently from the norm.

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3.2.3: The use of multiple embedded designs

The *multiple-embedded* design was utilised since it was felt that the sole use of a *holistic* approach would miss out critical areas of teacher development that are at the *individual* level. Unlike many other research studies, this study is intended to place a strong emphasis on individual reactions to the innovation. In addition, it was felt that with a holistic approach, the purpose of the study might have shifted during the course of the research. Consequently, the initial research question might have reflected a different orientation from the evidence collected.

One major advantage of a multiple-case design is that the use of various cases ensures that the study is more robust and hence adds to objectivity. The use of multiple cases was not intended just as a method of adding to the number of respondents as used in surveys or experiments but

rather every case served a specific purpose within the context of the study. Hence in this research, each of the three schools under study represents a unique *larger* case and each of the teachers, unique *smaller* cases nested within the *larger* cases.

In many studies, multiple case designs are considered comparative and as such cases are compared in a highly scientific manner with a rigid method of controlling variables. In this research however, there was no intension to develop a comparative study of the schools in question and as such, a thick and detailed description of each case was seen as a preferred method. This elaborate description was essential in making sense of the way in which each of the cases responded to the innovation. Indeed, as expressed by Yin (1989) multiple case studies need not be scientific and as such the methodological framework utilised for single or multiple case studies could remain the same with no broad distinction between them.

3.2.4: Limitations of the multiple-embedded design

The use of the multiple-embedded design is not without its limitations. Firstly, such designs are demanding on resources and time. Another limitation is the fact that these studies often focus only at the sub-unit level and on occasions fail to return to the larger units of analysis. In this study, it was ensured that analysis focussed both on the main units comprising the schools under study and the sub-units, representing the teachers of these schools.

3.3: The use of action research in the study

The research study also drew on action research principles. Action research involves diagnosing a problem in a specific context and attempting to solve it by adding to the

practitioner's functional knowledge of the phenomenon being dealt with (Cohen and Manion 1994). It is participatory in the sense that team members themselves partake in implementing the research. Carr and Kemmis (1986:162) viewed this form of research as self-reflective enquiry undertaken by participants in social situations. The development of action research originated from the ideas of Kurt Lewin (1946) who believed that advances in theory and social changes might simultaneously be achieved through action. He suggested that there are three important characteristics of action research namely, its participatory character, its democratic impulse and its contribution to social science and social change.

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Carr and Kemmis (1986) recognised two essential aims of action research namely, to *improve* and to *involve*. Ebbutt (1985) and Mc Kernan (1991) appended the ideas of Carr and Kemmis with their contention that action research is a systematic study of practitioners' attempts to improve educational practice through a reflection of their own actions. Cohen and Manion (1994) further extended the latter view in their perception of action research as a small-scale intervention in the functioning of the real world and a close examination of the results of such intervention.

Carr and Kemmis (1986) added that such intervention is intended to bring about improvement and is research based since it involves disciplined enquiry. Hence, it encompasses our current practice, our understanding of it and the context in which it happens. Action research participants monitor their own educational practices with the immediate aim of developing their practical judgements as individuals. Thus, the facilitator's role is to provide a sounding

board against which practitioners may try out ideas and learn more about the reasons for their own actions (Carr and Kemmis 1986).

According to Carr and Kemmis (1986) three conditions are necessary for effective action research. Firstly, the project must be related to a social practice. Secondly, the project proceeds through a spiral of cycles of planning, acting, observing and reflecting with each of these activities being systematically and self-critically implemented and interrelated. Thirdly, it involves those responsible for the practice in each of the moments of the activity, widening participation in the project gradually to include others affected by the practice and maintaining collaborative control of the process.

Elliott (1991:49) added that the aim of action research is that of improving practice rather than producing knowledge. He argued that the production and utilisation of knowledge is subordinate to and conditioned by this fundamental aim. Elliott believed action research intends to feed practical judgements into concrete situations and the validity of the theories or hypotheses it generates depends not so much on scientific tests of truth, as on their usefulness in helping people to act more intelligently and skilfully. This means that through action research, theories are not validated independently and then applied to practice but rather they are validated through practice. According to Elliott, action research is articulated as a bottom-up model as opposed to a top-down change strategy and therefore constitutes an insider rather than outsider form of enquiry. Stenhouse (1975) considered the main focus of action research in schools as encouraging teachers to become involved in their own practice and viewing themselves as researchers.

3.3.1: The action research cycle

One essential characteristic of action research is its *cyclical* nature and as such it is intended as a continuous process of improvement (Fig. 3.0). Mc Niff (1988) argued that action research is not a linear sequential activity because individuals often attend to changes in aspects of a problem that are initially peripheral to the problem's main focus at the same time as they attend to the changes in the main focus. She argued that the process is more closely related to several interrelated spirals, any one of which could take practitioners in different but relevant directions for the practices that they are researching.

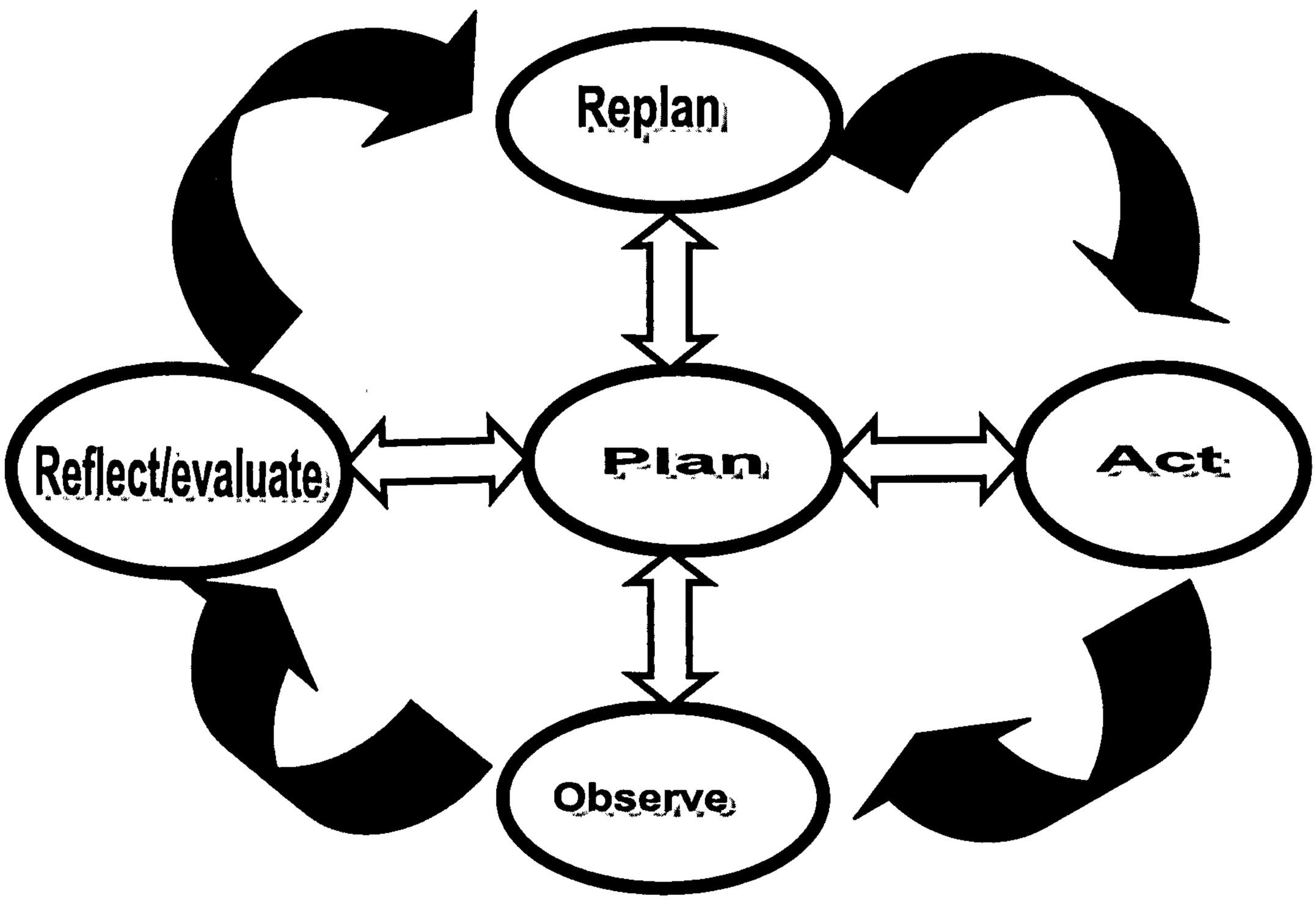

Fig. 3.0: The action research cycle

3.3.2: Advantages of action research

According to Stenhouse (1979), action research contributes not only to practice but also to a theory of education and teaching that is accessible to other teachers. One major advantage of action research is the fact that even after the intervention ends, participants continue to review, evaluate and improve on their practice. Nixon (1981) suggested that the approach is well suited for the usual constraints in schools.

3.3.3: Limitations of action research

Action research, like all other research methodologies, should not be considered a panacea for all research issues. As stated by Reason and Rowan (1981:246), the validity of the approach lies in the skills of the enquirer and as such, it is more personal and interpersonal than methodological. It should be noted that in this study, the skill of the enquirer was validated through extensive piloting of research instruments and through practical research studies carried out prior to this research. It must also be noted that the perceptions of Reason and Rowan (1981) does not mean that the methodological underpinnings of action research are flawed. Rather, as stated by Mc Niff (1988), it means that action research has as its philosophical base, an overarching awareness and respect for the integrity of individuals.

Winter (1982) drew attention to the problem of interpreting data in action research. He believed such tradition has a methodology for the *creation* of data but not [as yet] for its *interpretation.* In addition to its demands on teachers' time and energy, action research is sometimes criticised for encouraging focus on practical classroom ideas while the wider structural factors are accepted as unproblematic (Whitty 1985). Due to the above limitations,

other research methods, such as the case study and the use of grounded theory for data analysis, were used to compensate for the flaws of action research and to aid in the interpretation of research data.

3.3.4: Justification for the use of action research in this study

The study utilised *participatory action research.* The principal justification for the use of participatory action research in this study was the need for improvement in the practice of Dominican teachers. In this study, the aim of participatory action research was threefold. Firstly, it was intended to improve practice. Hence, it would supplement the development of research theory with a potential change in teachers' *practice.* Secondly, there was the goal of encouraging an ethos of collaboration through the utilisation and sharing of effective practices. Thirdly, it aimed to foster a change in teachers' perceptions of their professional roles. According to Elliott (1993), participatory action research is practitioner-based and therefore enables teachers to exercise the right to question the authority of past practice. Rudduck (1992) suggested that this form of research is a powerful tool since it allows teachers to critically reflect on what has been taken for granted all along.

3.4: Methodological perspective

The research further drew upon aspects of ethnographic principles with a qualitative research methodology. Burgess (1999) viewed ethnography as the study of people *'in situ'.* Fetterman (1989) defined ethnography as the art and science of describing a group or culture. Ethnography bears close relationship with the ethno methodological movement which began

with the work of Garfinkel. According to Garfinkel (1967), actors take an active part in the definitions of the situation. He indicated,

> *the activities whereby members produce and manage settings of organised everyday affairs are identical with members' procedures for making those settings 'account-able'*
> (Garfinkel 1967 pg. 1)

Garfinkel considered '*account-able*' as meaning '*observable-and-reportable*'. As argued by Hammersley (1999), ethnography is directed towards producing *theoretical*, *analytical* or *thick* descriptions. Ethnography is grounded on the premise of symbolic interaction, which puts forward an interpretative view of sociology, emphasising the actions of participants on the basis of their active experience of the world and the ways in which their actions arise from, and reflect back on experience (Williams 1981). Brown and Dowling (1998) viewed such approach as the immersion of the researcher in the practice in empirical settings. The ethnographer participates overtly or covertly in people's daily lives for an extended period in an attempt to collect whatever data available to throw light on the issues that are the focus of the research (Hammersley and Atkinson 1995). Hence, ethnography bears close resemblance to the routine ways in which people make sense of the world in everyday life.

Fetterman (1984) identified a number of characteristics that distinguish ethnographic educational evaluation from conventional ethnography. He indicated that, like traditional ethnographers, ethnographic educational evaluators begin with an initial aim to understand. However, unlike traditional ethnographers, their next step is to assess what is understood.

Fetterman also believed that ethnographic educational evaluators require less time on sight than the traditional ethnographer.

3.4.1: Rationale for the use of an ethnographic perspective

There are a variety of schools of thought within the social science spectrum with each having its own epistemological stance. However, what unites them is a common rejection of the belief that human behaviour is governed by general laws and characterised by underlying regularities as often portrayed by positivist approaches. Ethnographic studies argue that the social world can only be understood from the standpoint of the individuals who are part of the ongoing action being investigated. Hence, qualitative research methods are better at capturing the perceptions and practices of individuals within their own contexts.

3.4.2: The qualitative/quantitative divide

One major distinction between qualitative and quantitative research methods is that qualitative research produces data that is freely defined by the subject rather than structured in advance (Patton 1980). Kincheloe (1991:144) asserted that qualitative research is concerned with context and since human experience is shaped in a particular context it cannot be understood if removed from such context. Glaser and Strauss (1967) argued that qualitative research allows researchers to get *close to the data* and provide opportunities for them to derive their concepts from the data that are gathered.

Hammersley (1999:52) believed the structured character of quantitative methods involves the imposition of the researchers' assumptions about the social world and consequently reduces the

chances of discovering evidence discrepant with those assumptions. In addition, making claims of what happens in *'natural'* settings on the basis of data produced in settings that have been specifically *controlled* means engaging in largely implicit and highly questionable forms of generalisation.

3.4.3: Limitations of an ethnographic perspective

It must be noted that this research method is by no means flawless. One limitation is the constant criticism that such research yields *soft* and subjective data, since assessments are not made in terms of established standards (Dey 1993). In addition, during these studies, the researcher is often *the instrument.* According to Fetterman (1984:13), the shape of an ethnographic evaluation is based as much on the research design as on the training and personality of the ethnographer. It means therefore that validity hinges to a great extent on the skill, competence and rigor of the individual doing the fieldwork (Patton 1999). Guba and Lincoln (1981:113) added, since the naturalistic enquirer is himself the instrument, variations resulting from fatigue, shifts in knowledge and differences in training, skills and experience in the use of different instruments easily occur. A further limitation is the fact that such studies are often considered limited in generalisability.

3.5: Theoretical underpinnings of methodology

The study was grounded on a symbolic interactionist perspective. The use symbolic interactionists' principle rests on the grounds that it represents a distinctive approach to the study of human life and human conduct (Blumer (1969:2). Symbolic interaction rests on the analysis of the following three premises:

- *Human beings act towards things on the basis of the meanings*
- *Meaning is derived from, or arises out of, social interaction*
- *Meaning is handled in and modified through an interpretative process used by the person in dealing with the things he/she encounters* (Blumer 1969:2)

Symbolic interaction lodges its problems in the natural world, conducts its studies in it and derives its interpretations from such naturalistic studies (Blumer 1969: 47). Mead (1934) identified two levels of social interaction namely, 'the conversation of gestures' and 'the use of significant symbols'. Blumer (1969:8) extended Mead's analysis and referred to these levels as *'non-symbolic interaction'* and *'symbolic interaction'*. Blumer viewed non-symbolic interaction as a direct response to others' actions without interpreting such actions. Symbolic interaction, on the other hand, he defined as the interpretation of action. According to Blumer (1978), individuals interpret and define each other's actions instead of merely reacting to them. Further, Burgess (1984) argued that in using this theoretical perspective, it becomes essential to gather statements made by participants with a view to examine the various dimensions of the situation that they construct. Manis and Meltzer (1978:2) added to this argument in their contention that the thesis behind the symbolic interactionist perspective is that human beings *'construct'* their worlds and their realities. Hence, an understanding of human conduct requires a study of the actors' covert behaviour.

According to interactionists, authentic social knowledge is given to us in the immediate experience of our daily interactions (Coulon 1995). Coulon argued it should not be believed that such constitutes *'wild sociology'* without any theoretical hypotheses (pg.7). The symbolic interactionist approach assumes that the meaning that things have for human beings are central in their own right, hence ignoring such meaning is equated with falsifying the behaviour under

study (Blumer 1969). This theoretical approach is distinctive among others due to the fact that meaning arises through the process of interaction between people. As argued by Blumer, meaning is often taken for granted in the work of contemporary social science and psychological science. Blumer believed that this perspective does not merely give a ceremonious nod to social interaction, but it recognises social interaction in its own right.

It was with Blumer's perspectives in mind that teachers' actions and reactions in the Dominican context were closely examined. Hence, the symbolic interactionist perspective was adopted in this study since it was felt that more valuable data would be gathered in a pursuit of the meanings that teachers convey through their perspectives and actions in Dominican context.

3.6: Exploring the researcher's epistemology and its bearing on the study

Approaching the study from a symbolic interactionist perspective, the researcher's epistemological base leans greatly on interpretive and social constructivist paradigms. This belief was grounded partly from the comparison of various perspectives, as well as direct experiences pertinent to the acquisition and utilisation of knowledge. Drawing from experiences as a classroom teacher in Dominica, before being formally trained, the researcher's belief and subsequent classroom practice were centred upon those of more experienced but often untrained staff with whom he worked. This was not particularly surprising since, according to Zeichner et al. (1987:29), there is substantial evidence supporting the argument that beginning teachers' view their more experienced colleagues as highly influential in the process of learning to teach.

In addition, the researcher's practice was also shaped upon a recollection of his childhood experiences as a learner. As stated by Eraut (1994:60);

> *people tend to teach in the manner in which they were taught and as a result teaching strategies by novice teachers are already heavily influenced by their pre-conceived knowledge and private theoretical assumptions of teaching and learning.*

The above is particularly true when there are no established and sound theories of teaching to fall back upon. However, after formal teacher training and years of practice, he discovered that increased student interaction subsequently improves learning. The researcher's ontology was also attributed to a conviction that *society* and the presence of 'others' are pivotal in the acquisition of knowledge. This notion was linked to personal appreciation of learning and the methods from which he learnt best. Further, the researcher argues since individuals are influenced by *others* during interaction in real life contexts, any theory of learning should recognise such influences.

Further, the researcher's epistemological stance was grounded on a partial rejection of the positivist view that human behaviour can be explained through basic laws and regularities. Hence, unlike the interpretative paradigm, it assumes people's actions are mechanical products of psychological and social factors, thereby neglecting the creative role of individual cognition and group interaction. It must be noted that the positivist paradigm is in not way being totally rejecting since there are aspects of such paradigm that may serve to complement those of ethnographic perspectives. As argued by Burgess (1984:3) qualitative and quantitative approaches can complement each other and may be integrated in the practice of social research. The approaches are not only complementary but also compatible on occasions (Boaler 1997:4)

This does not necessarily mean that the theoretical underpinnings in this study are ambiguous. Rather, it means that there are aspects that can be of value from both paradigms and as such an unconditional extremist's stance is not advocated. As stated by Hammersley and Atkinson (1995), despite their differences, positivism and naturalism share much in common. They are both committed to the attempt to understand social phenomena as objects existing independently of the researcher. In addition, they both regard commitments on the part of the researcher as, for the most part, extraneous to the research process, and as a source of distortion whose effects have to be guarded against to preserve objectivity. On this point, the researcher would further argue that one characteristic of the interpretive tradition is to *utilise the best of both worlds*. Indeed, such perspective is mirrored through the utilisation of selected aspects of the positivist paradigm in this research through methodological triangulation.

3.7: Framework for the study

The study was undertaken based on previous research relating to the impact of teaching thinking on students' cognitive development in the Dominican context (Blaize 2000). It was then felt that an investigation focussing solely on teachers' perceptions was required so as to assess the impact of the teaching of thinking on teachers' classroom practices. In light of these issues the study aimed to:

- *Foster an ethos of continuous professional growth among secondary teachers through reflection on practice.*
- *Improve students' cognition through a teaching approach that would solicit a greater degree of classroom interaction and cognitive challenges.*

- ❖ *Establish and maintain a network of focussed collaboration among the staff of the schools involved in the research.*

3.7.1: Relevance of the study

This study was relevant on the grounds that it was designed to influence teachers' beliefs and practices through an *action research* undertaking in the schools concerned. Exposing teachers' beliefs and practices could possibly result in improved instruction and higher performance among students in the schools under study. The research was also relevant on the grounds that the results would be essential to the future educational policy decisions in Dominica. In addition, since most secondary teachers in Dominica enter the teaching profession with no formal teacher training, the support provided by the researcher throughout the period of study might have assisted teachers in improving practice. Finally, in addition to the acquisition of advance research skills, this research greatly assisted the researcher in understanding the reasoning behind the decisions of teachers.

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3.7.2: The target population and representative sample

The target population was the staff and students of three secondary schools in Dominica. The representative sample comprised Mathematics teachers at the three secondary schools under study (Table 3.0).

SCHOOL CODE	SCHOOL STATUS	STAFF POPULATION			MATHEMATICS TEACHERS			STUDENT POPULATION		
		Trained	Untrained	Totals	Trained	Untrained	Totals	Boys	Girls	Totals
A	State assisted	6	28	34	2	4	6	242	355	597
M	State owned	3	8	11	0	3	3	107	77	184
C	State assisted	13	18	41	3	7	10	0	477	477

Table 3.0: Population statistics of the schools under study

Teachers forming the representative sample possessed varying levels of qualification and experience. Besides the categories of Head of Department, specialist teacher, graduate teacher qualified and unqualified teacher, most members of staff had equal status since a horizontal organisational system existed in all schools in Dominica. Many of the teachers were untrained and even those with higher degrees rarely possessed a *Certificate in Education.* The experience of teachers varied greatly from the new teacher to those with well over a decade of experience (Table 3.1).

SCHOOL CODE	TEACHER CODE	TEACHING EXPERIENCE	HIGHER EDUCATION QUALIFICATIONS	CURRENT POSITION AT SCHOOL
A	1AM	10 years	Certificate in Education	Head of Department
	2AM	2 years	None	Classroom teacher
	3AM	3 years	None	Classroom teacher
	4AF	2 years	None	Classroom teacher
	5AM	6 years	Associate degree	Classroom teacher
	6AF	4 years	None	Classroom teacher
M	7MF	2 years	None	Classroom teacher
	8MF	1 year	None	Classroom teacher
	9MM	5years	None	Head of Department
C	10CF	13 years	BSc. Major Accounting, Minor Mathematics	Classroom teacher
	11CF	10 years	Bachelors in Computing Science BEd. Secondary Teaching	Head of Department
	12CM	10 years	Bachelors in Biology	Classroom teacher
	13CM	10 years	None	Classroom teacher
	14CM	4 years	None	Classroom teacher
	15CF	1 year	None	Classroom teacher
	16CF	1 year	None	Classroom teacher
	17CF	1 year	None	Classroom teacher
	18CF	1 year	None	Classroom teacher
	19CF	1 year	None	Classroom teacher

Table 3.1: Experience and qualifications of Mathematics teachers at the schools under study

3.7.3: Sampling procedures

The research utilised *purposive sampling* since it was considered the most appropriate method for the selection of schools for the study. Through this method the population was deliberately selected because it was felt that the most valuable data would be obtained from this population.

3.7.4: Rationale for selecting the population

The schools in question were selected mainly because they were located at different Educational Districts on the island. This meant that they represented an excellent cross-section of teacher diversity and of student intake as reflected in the Dominican context. Both public and government assisted schools were used in the research study. *Public* or *state owned* schools were considered those completely managed by the state whereas *government assisted* schools were considered those partially funded by the state. The schools under study represented a high degree of diversity. Some of the major areas of diversity were in terms of the school status, financial resources, size, intake, location, population, student to teacher ratio, performance, management style, school effectiveness, teacher motivation, pupil motivation, parent involvement, staff qualification and experience among many others. The diversity of schools in the sample was suited for the purpose of this study.

One may argue with so many dependent variables, as represented in the diversity of the sample, it is difficult to prove the dominant feature affecting potential change in teachers' beliefs and practices. However, this diversity was deliberate in order to prove that all the above factors might affect the decisions that teachers take on a day-to-day basis. The latter argument cuts through the very heart of this research study. The intention was not only to make generalised arguments based on a comparison of schools and teachers as done in many research studies, but also to assess each school based on these contributing factors, then assess each teacher based on the factors as reflected in his/her respective school coupled with other personal factors.

3.7.5: Data elicitation techniques

The main data gathering techniques were observation, journals of reflection and semi-structured interviews.

3.7.6: Knowledge interest

The knowledge interest in this study drew upon epistemologies of *emancipation* and *empowerment*. These were the primary focus of interest since one of the objectives of this research was to empower teachers to an extent that they would recognise and implement relevant educational programmes so as to ensure sustained changes in their practice, subsequently resulting in improved student learning.

3.7.7: Exploring the research instruments utilised in the study

3.7.7.1: Interviews

Robson (1993:228) defined research interview as a conversation with a purpose. Cohen (1976:82) held the view that interviewing, like fishing, is an activity requiring careful preparation, much patience and considerable practice if the eventual reward is to be a worthwhile catch. Interviews are used when the researcher requires in-depth insight into a topic drawing from information provided by fewer informants (Bell 1993). Although interviews appear remarkably simple, Powney and Watts (1987) argued such apparent simplicity is deceptive. Interviews range on a continuum of formality with the fully structured interview at one extreme, the unstructured interview at the other extreme and the semi-structured interview at some point on the continuum. In this study, the *semi-structured* interview was the focus of interest since it was expected that participants would have a fair

level of independence in terms of their responses but simultaneously keeping to the focus of the study.

- **Utility and value**

Interviews may be used to gain access to situations where participants of a research may not wish the researcher to be present. With *semi-structured* interviews, the researcher determines a series of questions in advance but reserves the freedom to modify their order, change wording, omit questions and include additional ones based on what seems to be most appropriate in the context of the conversation. In addition, according to Robson (1993), the interviewer is free to provide prompts and probes to facilitate responses. Semi-structured interviews rely heavily on open-ended questions. In addition, they allow the interviewer to probe deeply into the roots of responses, clear up misunderstandings and test the limits of respondents' knowledge.

- **Advantages**

According to Robson (1993), interviews are capable of providing rich, highly illuminating material. One major advantage of all interviews is their adaptability (Bell 1993; Robson 1993). This means that ideas can be followed up, responses can be probed and the perceptions and interpretations of others can be questioned. Robson (1993) suggested that face-to-face interviews offer the possibility of modifying one's line of enquiry, following up interesting responses and investigating underlying motives. He believes that non-verbal cues may give messages that assist in understanding the verbal response of interviewees, possibly changing or even, in extreme cases, reversing its meaning.

- **Limitations**

The lack of standardisation that may be implied in the flexibility of some interviews raises concerns about reliability and as such biases are difficult to rule out (Robson 1993). In addition, interviews are often considered time consuming. Furthermore, due to the nature of the questions used, there is a higher possibility of loss of control by the interviewer. The interviewer inevitably brings to the interview context personal perspectives no matter how closely he tries to obey the *'rules'* of the process (Powney and Watts 1987). Such influences may be related to physical characteristics, while others may be related to perceptions, expectations and motives, among others. Powney and Watts (1987) suggested that the vulnerability of interviewees during an interview situation might encourage them to tailor their responses to fit their imagined audience. Such vulnerability may be partly due to pressures to maintain self-esteem. Hence, if interviewees suspect that they may at some point be confronted with their own inconsistencies then they may withhold such information.

3.7.7.2: Observation

Simpson and Tuson (1995:16) believed observation is the most satisfying research technique since it brings forth the *sweetest* of data. According to the authors, research observation transforms the personal experience of just looking into a public event by the systematic recording of what we see. Hence, we open up opportunities to examine our assumptions, challenge them and offer alternative viewpoints. This research will draw predominantly on *participant observation* since the researcher will be actively involved in conducting in-service support sessions at various points during the research period.

3.7.7.3: Participant observation

Lacey (1976:65) defined participant observation as the transfer of the whole person into an imaginative and emotional experience in which the fieldworker learns to live in and understand the world. Bryman and Burgess (1999) described participant observation as a method in which the researcher immerses him/herself in a social context with the aim of uncovering the meaning systems of participants in that social context and hence to see the world from their point of view. According to Simpson and Tuson (1995), participant observation is the most subtly intrusive of all observational methods since involvement gains the researcher access to the normally unseen heart of professional activities. Francis (1992) suggested that as participant observers, we attempt to gain the trust and acceptance of people by participating in their lives and activities. Hence, we hope that they will trust us as ordinary members of their group and that they will behave naturally in our presence, thus reducing the problems of *observer effect.*

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Burgess (1984) identified four dimensions of participant observation namely, *complete participant*, *participant as observer*, *observer as participant* and *complete observer.* In the first dimension of complete participation, the researcher's role is kept secret. Through this method, consent cannot be gained for the research and as such there are immense ethical problems. Burgess identified several problems associated with such role. Firstly, the researcher may change the behaviour of the group. Secondly, he/she may be handicapped by the role that he/she has adopted. Thirdly, he/she may play the adopted role so efficiently that he/she may go *native* and no longer collect data or record observations that are made.

The second dimension of *participant as observer* involves participation as well as observation through the development of relationships with informants. According to Roy (1970:217), the participant as observer not only makes no secret of his investigation, but also makes it known that research is his overriding interest. This method has the potential for collecting rich information, but there are underlying problems. Firstly, there is the potential for conflict of interest between the researcher's role and the nature of the data collected and hence the potential for bias. Secondly, there is the question of depth in participation.

With the *observer as participant*, there is marginal participation and therefore contact with informants is brief, formal and openly classified as observation. Such brief observation, in addition to posing problems of access to observation settings, may also mean a superficial understanding of the meanings that participants utilise in social situations. Finally, Burgess (1984) characterised the *complete observer* through the practice of eavesdropping and recognisance in which the researcher is removed from sustained interaction with informants. As noted by Junker (1960) dimensions of participant observation are not sharply distinguished and as such the field-worker may find his activities shifting through time from one dimension to the next as he continues observing the same individual or group.

- **Utility and value**

Burgess (1984) suggested that the value of being a participant observer lies in the opportunities that are available to collect rich, detailed data based on observations in natural settings. Furthermore, the researcher can obtain accounts of the participants' own language that gives access to the concepts that are used in everyday life. Consequently, the researcher can utilise

such observation in parallel with his/her theoretical insights to make seemingly irrational behaviour comprehensible to those beyond the situation being researched.

Burgess (1984) claimed that in doing participant observation, it is the researcher's aim to observe events while causing as little disruption as possible to the social context. In this respect, developing trust and establishing relationships are a crucial part of the researchers' involvement in the social scene. It can be said that the observer should act as a thermometer in the sense that the measurement should not disrupt the existing conditions. Hence, the researcher needs to be able to see things as they normally occur, with participants unaffected by any awareness that research is happening. According to Simpson and Tunson (1995:14), participant observation requires the researcher, not only to be fully engaged with the people and context that is being researched, but also to be detached enough from this engagement to be analytic about his/her own feelings, preconceptions and actions within that setting. Hence, the researcher adopts a dual role and must commute between being involved and being detached.

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- **Advantages**

Participant observation is beneficial since it provides direct access to research settings and to the events and interactions that are the focus of research. Hence, the observer is able to witness events that may be sub-conscious to participants, those that they may not be able to discuss in an articulated way. In addition, observation gives permanent systematic records of social interactions and since it is extremely flexible, it can be applied to a variety of research techniques.

- **Limitations**

Participant observation, in addition to being time-consuming, is disadvantageous on the grounds that it is often regarded as subjective, bias and lacking in precise quantifiable measures (Cohen and Manion 1989). As such, the observer may concentrate on events that capture his interest, often at the expense of more significant events. Bell (1993) believed that on occasions the researcher's interpretation of what is seen might not always be reliable since he/she will have a particular focus and interpret significant events in his/her own way. There is also a danger of the observer getting too familiar with the participants thus losing their perspective and becoming *blind* to the peculiarities that they are suppose to be investigating. In addition, observation is inappropriate for capturing information on attitudes, opinions, intentions and meaning. One may also argue that there is always the possibility of *observer effect* where the presence of the observer may influence the actions of participants. Further, participant observation may inevitably lend itself to predisposition that may influence certain aspects of research.

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In this study the use of participant observation was justified on the grounds that this was one of the main avenues to identify potential differences between teachers' beliefs, pertinent to teaching and learning, and their subsequent classroom practices. It must be reiterated that individuals may not always behave in ways that they proclaim and therefore observation is essential in an attempt to assess the true relationship between perception and behaviour.

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3.7.7.4: Structured observation

This method requires categories of behaviour to be pre-specified and the rules for classifying such behaviours into different categories that are pre-determined and applied by all researchers

using the schedule. According to Simpson and Tuson (1995), the purpose of such schedules, is to quantify the incidence of particular classroom events, to seek relationships that can be tested through statistical methods and which may be generalised to hold across similar cases. Such schedules are unaffected by personal bias as long as the observer applies the correct procedures for its use. It must be noted that one of the major limitations of structured observations is that important features may be overlooked because they fall outside the pre-defined categories (Francis (1992).

3.7.7.5: Journals of reflection

The research employed diary accounts of teachers as one of the many data collection instruments. This comprised personal accounts of observations, feelings, reactions, emotions, attitudes, interpretations, reflections and haunches relating to classroom events. Bell (1999:226) suggested that such accounts allow people to be *'heard in their own terms'*. Allowing teachers to keep journals of daily events allows researchers to gain access to activities that they do not witness or those to which they have no access (Burgess 1999).

The use of journals for the collection of research data was justified since reflection on one's actions and the analysis of one's performance forms essential competencies under the umbrella phrase *'professional activity'*. Furthermore, it was impossible for the researcher to observe all activities that occur in the classroom and hence the need to obtain accounts from participants. One major limitation of journals is the authenticity of entries (Gibson 1995). In addition, they can be time consuming for both researchers and informants since informants will need training and perhaps follow-up visits in order to maintain their motivation to keep diaries.

3.7.7.6: The researcher's field notes (analytic memo)

In this research, the researcher kept a field diary so as to validate and track the sequence of events during the practical research activity. Bell (1999) argued that the field diary is the counterpart of the informant's account. It involves a record of observation, activities and thoughts that may assist in understanding the actions of participants. Burgess (1999:257) identified three major elements of the contents of such diaries. Firstly, it involves a substantive account of events that have been observed and the informants who have been interviewed. Secondly, a methodological account that involves autobiographical details outlining the researcher's involvement in the social situation. Finally, there should be an analytic account involving questions and haunches raised during the research process. Bryman (1993) was of the view that in typical ethnography, field notes are rarely available although these are quite helpful in allowing the reader to formulate his or her own haunches about the perspectives of the people who have been studied. In this study, field notes were essential since the on-going analysis of field notes resulted in amendments to various aspects of the field component of the research.

3.8: Piloting research instruments

Research instruments were carefully designed and then piloted before they were introduced to the research setting. The research study was undertaken in Dominica but most of the piloting phase was done in England. One may argue that the educational context of Dominica is slightly different from that of England and as such the piloting phase might have been limited in this respect. However, the decision to pilot the instruments in England could be justified on several grounds.

Firstly, due to the fact that the innovation had only been introduced to the Dominican context on a small scale, and focussed on another aspect of study it difficult to pilot the instruments in such context. In addition, one might also argue that inasmuch the thinking skills programme intended for Dominican students was the same as that used by the teachers in the pilot population, the above decision could be justified. Further, piloting aims to inform the efficiency of research instruments, to aid the researcher in effectively implementing these instruments and to give an indication as to the pattern of research results. Hence, it might be argued that in the case of this research, it was felt these goals were achieved through the pilot.

3.8.1: Piloting journals of reflection

The journals were designed to elicit teachers' reflections on their classroom practice. Since teachers' inner thoughts were not readily accessible, the researcher was of the opinion that the best method of obtaining such thoughts was through the use of journals. In addition, there was the hope that the use of such instruments would assist teachers in making tacit theories and routine practices explicit and hence improving their teaching.

Guidelines for reflection were provided so as to facilitate teacher reflection. The guidelines were not intended to be fixed but rather to help stimulate teachers' thinking (*Appendix F*). The researcher firstly identified three phases of reflection based on different time periods namely; *prior to lesson delivery*, *during lesson delivery* and *after lesson delivery*. From these phases a number of issues related to teaching and learning were identified. These were further refined after careful consideration and discussions with other academics, including research supervisors. The journals were then piloted on a number of teachers in the Northeast of

England who were at various stages in adopting the thinking skill programme. The teachers were asked to enter their reflections on the teaching of thinking lessons for four weeks ensuring that there was at least one entry every two weeks. Some teachers felt that the categories for reflection could be further extended and hence suggested other aspects that could have been included. Other teachers felt the journal entries could at times be tedious. Based on the suggestions the guide was revised and there were additional areas for reflection, particularly in the category of 'reflection after lesson delivery' (*Appendix G*).

3.8.2: Piloting interview schedules

The interview schedules were divided into *pre-* and *post intervention* issues. The questions were designed in order to assess teachers' perceptions as to potential changes in beliefs and practices after lesson delivery (*Appendices H and J*). Interview questions were discussed with other researchers and research supervisors and the necessary modifications were made. The interview questions were then piloted on teachers with similar characteristics to those that were to be used in the population under study. The *pre-intervention* schedule was piloted on teachers who were at the initial stages of implementing the thinking skills programme, while the post intervention schedule was used with others who were at advanced stages of implementation. Based on the results of the pilot, it was discovered that some questions were too general, others were worded at levels beyond the practical understandings of teachers and on some occasions others were slightly ambiguous. Recommendations obtained from the pilot informed a revised model of the interview schedules (*Appendices I and K*).

3.8.3: Piloting observation checklists

The research utilised both structured and descriptive observation. Audio-visual equipment was not used during observations for several reasons. Firstly, it was felt that such devices were not flexible and would not capture all events. Most importantly, the researcher was of the view that the use of such objects would have distorted the natural setting that the observation was intended to capture.

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3.9: Developing codes for the structured observation

In order to facilitate analysis of structured and descriptive observation results, coding schemes were developed (*Appendices L and N*). The object of concern was the teaching practices of classroom teachers. The coding schemes were done in a mutually exclusive and exhaustive format. The latter meant that one code was associated with a particular event (exclusive). However, there was a distinct code for every possible event that was of interest to the researcher (exhaustive). The observation schedule was adapted from the work of Flanders (1970).

3.10: Rationale for selection of the behaviour categories for observation

It could be argued that there is so much to observe in a typical classroom that one would never be able to see and record all events. In addition, in every research undertaking the decision as to what to record and interpret is often bias and might be based on the objectives of a research study. In the case of this research, the object of interest was teachers' instructional styles and as such the schedule was designed based on these issues. Hence, during the construction of the

observation schedule, a series of behaviours were identified and defined (*Appendix M*) based on their immediate relevance to the object of the study.

The behaviours identified were then discussed with academics and modified as appropriate. In order to add to the validity of this instrument, it was piloted on several video-recorded lessons. After this initial pilot, it was discovered that there were far too many categories for observation. The latter led to inefficiency and a lack of reliability during the administration of the schedule. In an attempt to further add to the reliability of the instrument, there were several other pilots during actual *thinking maths* lessons with teachers from the Northeast of England. These brought to light additional flaws in the instrument particularly in the number of categories to be observed and in assigning values to less quantifiable classroom behaviours. As such, further modifications were required (*Appendix N*).

3.11: The practical research activity

3.11.1: Ethical Issues

The first consideration during the data collection stage of the research was that of dealing with ethical issues. One potential issue was obtaining informed consent during the research study. Although the researcher was somewhat familiar with the research settings, issues of access were not taken for granted. Written consent was acquired from the relevant authorities, including the Ministry of Education. In addition, permission was obtained from the principals and teachers of the schools in question prior to the commencement of the research (*Appendices O and P).*

A conscious effort was made to avoid situations where the researcher plays the role of reformer. Glesne and Peshkin (1992) believed this occurs where researchers attempt to *right* what they judge to be *wrong*. This was a particularly sensitive issue in this research since there was no clear-cut rationale for determining what is to be perceived as right or wrong. Hence, although it was widely agreed, even by teachers themselves, that the teaching approach adopted in Dominica was not the best for student learning, one could simply ask, who is to determine whether the suggested innovation was the best approach for Dominican secondary schools? This question was one at the core of the research study and although the innovation was considered beneficial, the researcher was careful not to be prescriptive. Hence, teachers were encouraged to adopt a generic approach to the teaching of thinking through the modification of thinking lessons where needed. Issues of confidentiality and anonymity were of concern and therefore anonymity was assured at every stage.

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3.12: Phases of the research

Phase One

The first phase of the research involved re-orientation of the researcher in the setting. According to Wax (1971), the process of initiation and re-socialisation of the researcher that occurs at the beginning of the research study influences the outcomes of the research report. In this study the researcher ensured that the necessary familiarisation procedures were effectively undertaken in order to facilitate the field component of the research study. In an effort to minimise the possibility of *observer effect*, there was period of *habituation* (Brown and Dowling 1998:48) where the researcher immersed himself in the setting for at least one month prior to formal lesson observations. During this period, teachers were interviewed to solicit

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information pertinent to their beliefs on the teaching and learning of Mathematics. In the following two months of the school term, teachers under study were observed in order to obtain baseline data pertinent to their practices. In order to enhance the reliability of observations, an attempt was made to establish inter-rater agreement. This involved the researcher, along with an additional observer, recording classroom observations for all teachers and then comparing their ratings to determine an average of occurrences for each feature observed. Towards the end of this phase, a series of staff workshops were conducted where participants were trained in teaching the *thinking* lessons and in making journal entries.

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Journals were intended to encourage teachers to reflect on their practice with the hopes of improving practice. After each workshop, teacher feedback was obtained through workshop evaluation forms (*Appendix Q*). The purpose of the workshop evaluation was threefold. Firstly, it was intended to inform the effectiveness of workshops. Secondly, it would solicit information pertinent to teachers' future needs. Finally, the evaluation would assist in the analysis of research data in terms of receptivity of schools to the innovation. Feedback from teachers was entered in the researcher's field diary and the appropriate amendments were made during the practical research activity so as to accommodate teachers' needs.

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Phase Two

In the next phase of the study, teachers were allowed to begin implementation while lesson observations continued. Implementation involved the teaching of one *Thinking Maths* lesson from the *CAME* pack every two weeks. On most occasions during observations teachers were allowed to teach the same topic so as to minimise differences that could be related to interest

and relevance of individual lessons. Adequate support was provided during this phase, including demonstrative lessons. During this phase, teachers were asked to enter their reflections in the journals after every *Thinking Lesson*.

At selected points during the implementation phase teachers met in the form of focus groups at a school level in order to discuss the progress of the innovation and to share their accounts of successful or unsuccessful strategies or interesting developments. These sessions were not intended for data collection for the purpose of extensive analysis but rather they played a supportive role in ensuring that the research progressed smoothly. Grounded theory was used for the analysis of research data. Hence, data analysis was ongoing. The researcher's field diary was instrumental during the process since assumptions and interesting observations were recorded and further explored. These developments served to determine subsequent action that should be taken in the field.

Phase Three

The final phase involved teachers working with a higher degree of autonomy and as such the researcher kept support to a minimal. This phase also involved continued observations and diary entries in order to assess potential changes in teachers' practices. At the end of this period, teachers were formally interviewed in order to obtain information on possible changes to their beliefs and practices.

3.13: Trustworthiness of the research

It is essential that a researcher persuades his audience that the findings of an inquiry merit their interest. In this research four areas of credibility were explored in order to validate research claims. Firstly, the issue of *'truth-value'* was considered since it established confidence in the findings for the individuals with whom, and the context in which the research was carried out. Also of importance were issues of *applicability* or the extent to which the findings of the study were applicable to other individuals and contexts. Finally, issues of *neutrality* ensured that research findings were determined by research participants and the conditions of the enquiry as opposed to the biases, motivation or interest of the researcher. The following sections describe how the above concerns were addressed during the research.

3.14: Addressing the issue of objectivity

Phillips (1989) considered an objective study as one that is open to scrutiny and challenge. Scriven (1971) believed objectivity relates to what a number of subjects or judges have experienced. Thus, the usual criterion for objectivity is inter-subjective agreement. This means that if multiple observers can agree on a phenomenon, the collective judgement may be considered objective. Ball (1990) held a radical view of objectivity as it relates to qualitative research in his assertion that,

> *it is perverse that a tradition committed to the search for subjectivity as qualitative research does, should attempt to cloak itself in the mysteries of objectivity* (pg. 46).

Ball instead advocated rigour in qualitative studies. He argued that rigor lies firmly upon the researcher's awareness of the conclusions that could be made given the nature of the data that was and was not collected (pg. 40). There was a conscious attempt to reduce any potential

biases in this research study. Firstly, there was theoretical and methodological triangulation, multiple methods of data analysis and the expertise of professional colleagues, particularly when observing teachers in action.

3.14.1: Triangulation

Triangulation relates to the use of multiple sources of evidence during a research study. Triangulation by method is particularly essential since the exclusive reliance on just one method might be bias and might distort the researcher's picture of the particular slice of reality being investigated. In this research, there were different methods of data collection mainly in the form of interviews, journals, observation and the researcher's field diary. In addition to triangulation by methods, combined level triangulation was utilised in this study to enhance objectivity. This involved the use more than one level of analysis from levels namely, individual, interactive and the level of collectives [cultural and organisational]. The analysis of research findings was made at individual and school levels with the hopes of getting a global view of teachers' perceptions and practices as they relate to the context of Dominica..

3.15: Addressing the issue of validity

Guba and Lincoln (1989:13) viewed validity as a positivist notion and identified a substitute concept of *authenticity* in qualitative research. Maxwell (1992) argued that not all accounts of a situation, phenomenon, activity, text, institution or programme are equally useful, credible or legitimate (pg. 182-183). He contends that validity is not an inherent property of a method but pertains to accounts or conclusions reached by using that method in a particular context and for

a particular purpose. According to Cronbach (1980:103) the job of validation is not to support an interpretation, but to find out what might be wrong with it.

- ❖ *Internal validity*

Internal validity is described by Lincoln and Guba (1999:38) as the extent to which variations in an outcome can be attributed to controlled variation in an independent variable. Hence, it can be argued that in studies where the researcher attempts to determine a relationship between two variables, it must be ensured that there are no other variables that may have actually interfered with the result. In this study the only independent variable of concern was that all the participants under study were Secondary Mathematics teachers. Hence, although attempts were made to ensure *internal validity,* the researcher was not keen on making conclusions as to causal effects but rather to understand each case based on the relating factors unique to the case in question.

Efforts were made to ensure internal validity through *pattern matching* and *time series analysis*. According to Yin (1989), pattern matching involves comparing an empirically based pattern with one or more predicted patterns. Hence, the results of this study were analysed to establish links between the theoretical propositions, and the actual outcomes. Time series analysis relates to tracking changes over time. During the study, there were three phases [pre-intervention, intervention and post-intervention] where potential changes were recorded at different points.

❖ *Descriptive validity*

Descriptive validity was also of concern in this research. Maxwell (1992:228) described descriptive validity as the extent to which the description or account of a situation is accurate. This relates to misconceptions, misinterpretations and pre-conceived notions. In an effort to avoid misinterpretation during this research, teachers' mannerism and attitudes were considered as essential as their actual contributions.

3.16: Further enhancing credibility in the research findings

Several steps were taken to assist in further maintaining credibility of research findings. Firstly, there was prolonged engagement in the field and persistent observation. There was also a period of peer debriefing where the researcher exposed his study to others who were unfamiliar with aspects of the study in a manner that paralleled an analytic session. The latter was intended to explore aspects of the enquiry that might otherwise remain implicit within the researcher's mind. Finally, there were member checks where results, interpretations and conclusions were tested with members of the stake-holding groups from which the data was extracted. This process provided the opportunity to access the actual intentions of respondents and gave them a chance to change existing information or to volunteer additional information.

3.17: Constraints

In this study the principal asset, which was the researcher as an insider, had the potential to be the mole in the path of its objectivity. Due to the nature of the study and the role of the researcher as an in-service school advisor, his active involvement in the implementation of the innovation meant that data collection and analysis might have been potentially compromised.

This meant that there might have been *pockets* of subjectivity during data collection and analysis. A related concern was the fact that participants might have been tempted to provide information that might contribute positively to the outcomes of the research. Hence, all necessary precautions were taken to be as objective as possible. One such step was the utilisation of several sources of evidence namely, interviews, observation, journals of reflection and the researcher's field diary, among others.

In addition to the above, there were instances where some teachers found it difficult to maintain up-to-date records of their thinking lessons for such an extended period. A similar problem was experienced by Elliott (1991) during the *Ford Teaching Project* (1973-75) where teachers and students were encouraged to keep diaries as part of the data collection methods of the study. During the initial stages of the study it was discovered that only few teachers used the data collection methods as suggested. Hence, the researchers were forced to adopt a proactive approach by identifying a few supportive teachers. These teachers were then allowed to discuss the ideas openly with peers, which encouraged greater interest among other teachers. The problem of limited participation was evident on a large scale during this research. However, like Elliot (1991), the researcher identified a few leading, influential teachers, mainly the Heads of Departments, who were willing to contribute to the research activity. The use of peer pressure from these influential members of staff enhanced participation from staff members who were less willing.

3.18: Limitations of the study

One could, quite rightly, argue that any study of this nature should incorporate findings from teachers, as well as the viewpoints of students. This argument was strongly considered in this research. However, students' direct responses were not utilised for two primary reasons. Firstly, research was done prior to this study, which established the impact of the teaching of thinking on secondary students' learning in the Dominican context (Blaize 2000). Hence, it was felt that presentation of the findings from students would be an unnecessary replica of the past study. In addition, the study intended to probe deeply into teachers' perceptions and practices and therefore it was felt that although an investigation into students' perceptions would increase the scope of the research, it would compromise the depth of the study. It must be mentioned that students' reactions were considered, to some extent in this study, through an overview of teachers' perceptions of students' responses to the teaching of thinking.

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Further, it was of concern that although adequate training was provided during the practical aspects of the research, teachers were not totally familiar with the teaching of thinking and this inevitably influenced teacher confidence and subsequently efficiency of implementation. It must also be admitted that the research might have been limited since the results could not be stated in universal terms. It must be noted, however, that the research study was not only intended to make a contribution to theory, but also to make a contribution to *practice*, specifically through the use of action research in the school context. Further, one might argue that inasmuch as teachers under similar settings and context are able to relate their decision-making to those made by the participants of the research, such relatability may prove to be just as essential as generalisability. It must also be re-iterated that the study was not intended to

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collect representative data but rather to explore the variety and range of perceptions and practices of teachers in the schools under study.

CHAPTER 4

DATA PRESENTATION AND INTERPRETATION

4.0: Purpose of the study

The study intended to investigate the extent to which a cognitive acceleration programme contributed to the professional development of teachers in the Dominican context in terms of their ability to reflect on practice. In addition, there was an effort to determine the degree of change (if any) in teachers' beliefs and/or practices as a result of such innovation. Hence, the main research question and sub questions were as follows:

- **Research question:**

  How does the teaching of thinking skills influence beliefs and practices of secondary teachers in the Dominican context?

- ***Sub-questions:***
  - *How does the teaching of thinking impact on traditional beliefs and practices?*
  - *What is the relationship between teachers' beliefs and practices on teaching of thinking?*
  - *How can teacher reflection influence their perceptions and practices?*
  - *How does the teaching of thinking impact on staff collaboration?*

4.1: Interpreting research findings

The analysis of research data was done at two levels namely, the individual teacher level and at the school level taking into account the contributing factors at each of the schools. Analysis

was done one school at a time since it was felt that implicit theories could be tested with individual schools and then attempts could be made to validate these theories using the other schools under study. It was also felt that through this method, a more profound analysis would be made of each of the cases with respect to the schools in question. The presentation of research data in this study was predominantly qualitative. However, there was also a quantitative element. Grounded theory was utilised for data analysis. This is a qualitative method that uses a systematic set of procedures to develop and inductively derive grounded theory about a phenomenon (Strauss and Corbin 1990:24). The purpose of grounded theory in this study was to build theory that is trustworthy and that illuminates the topic and context of study.

4.1.1: Coding using grounded theory

Strauss and Corbin (1990:57) defined coding as the process by which data are broken down, conceptualised and put back together in new ways. Analysis in grounded theory comprises three major types of coding namely, *open, axial* and *selective coding*. *Open coding* involves breaking down, examining, comparing, and categorising data (Strauss and Corbin 1990). During this process, the data are broken down into discrete parts and compared for similarities and differences. In so doing, assumptions are questioned and explored. *Axial coding* relates to a set of procedures where data are put back in new ways after open coding by making connections between categories. Hence, it involves the formation of new and wider categories. According to Strauss and Corbin (1990), *selective coding* involves selecting the core categories, systematically relating it to other categories and validating those relationships. The study utilised the above coding strategies at one point or another during data analysis.

4.2: The selection of research data

One of the major issues relating to the presentation and subsequent analysis of data in any research study is the process of deciding what is considered relevant or irrelevant. As far as this issue is concerned, this research study was not an exception. One may argue that research is inevitably biased since it is impossible for the researcher to consider all the data collected during the research process. Hence, there is always a process of filtering the data and the subsequent utilisation of aspects that are in some form relevant to the research study.

The question therefore arises, *who is to determine which portions are relevant and which are not?* This question is crucial since it can be asked of any research study. According to Ball (1995:259) there is a danger of reducing the complexity of experience in research settings and striving towards a theory that *'it all makes sense'*. Dey (1993) further stated that the researcher, in fact, produces any data regardless of the method of collection. He believed that data is not out there to be collected but rather the researcher has to notice and treat the information as data for the purpose of the research.

The decision pertinent to selection of relevant data had to be made at some point in this study and therefore the researcher attempted to include all aspects that were of interest. In addition, the data was explored thoroughly and thoughtfully in order to ensure that these aspects were adequately considered. Through this process, competing theories were explored as well as data which appeared '*not to fit*' into the expected norms.

Since there was limited formally documented evidence pertinent to the schools in question, much of the information relating to teachers' motivation and attitudes towards the innovation, as well as school success and management styles, was base on the researcher's own experiences while interacting with the schools in question as well as accumulated research data during the study. Due to the fact that Dominica is a very small island, the researcher's role as in-service training provider for schools on the island afforded him the opportunity of interacting with several schools both on a personal and professional level over the years. Hence, he was at a fortunate position of having elaborate knowledge pertinent to most of the teachers and principals under study. In addition, further information was gathered through rapports with staff members, among other data collection methods during the research process.

One may rightly argue that gaining background knowledge of participants and schools, although advantageous, has its disadvantages in the sense that such familiarity might foster a preconceived interpretation of participants' actions. This issue was of concern at every stage of the research study and as such there was a conscious effort not to prejudge participants based on factors known to the researcher before the research study was undertaken. The following presentation and analysis represented an impartial consideration of the relevant data gathered through the study.

4.3: Coding and creating categories for data analysis

Teachers of each of the schools were assigned codes in order to enhance anonymity. These codes comprised a number in chronological order from one to nineteen (1-19) to represent each

teacher, a letter **A, M** or **C** representing each school and the letters **M** or **F** indicating each teacher's sex.

Interview data was divided into two categories namely *pre* and *post intervention* issues. The use of a pre intervention instrument was mainly to establish baseline information on teachers' beliefs and practices related to the teaching of Mathematics. Hence, the post intervention instrument was intended to measure the degree of change in teachers' belief and practices after the intervention. Teachers were interviewed on a *one-to-one* basis. This method of interviewing was selected in order to identify the beliefs and practices of individuals based on the factors influencing each individual. In each of the cases under study, the responses from pre and post intervention interviews were sub-divided into four main categories namely:

- *Beliefs on teaching*
- *Teaching practice*
- *Professionalism and professional growth*
- *Teachers' accounts of students' attitudes to their teaching*

4.4: (*Case 1*) Describing '*School A*' prior to research activity

The Mathematics Department of this school was made up of six (6) teachers. Each teacher was assigned a number in chronological order (**1-6**), along with the school code (**A**) and a letter representing teachers' sex (**M** or **F**). Hence, in order to enhance anonymity, teachers were assigned the following codes: **1AM, 2AM, 3M, 4AF, AM, 6AF.** The following is a description of the school prior to the practical research activity.

❖ *School setting*

This was a large, state-assisted, rural, co-educational school. It was founded in 1979 and located approximately 36 miles away from the capital city. The school was not very spacious. Hence, some classrooms were overcrowded and to this end, proposals had been made for an annex to the building so as to reduce class size. The pupil to teacher ratio at this school was one teacher to nineteen students (1:19) but this figure did not reflect class size since it represented the overall number of students as compared to the number of teachers at the school. Many of the parents resided in the neighbouring community. The school maintained a very good relationship with its clientele and had the support of the parent population.

❖ *Principal and staff*

The school principal used a collaborative management approach and appeared to be attentive to the needs of teachers. Less than a quarter of the school's staff was formally trained and the same applied to the staff of the Mathematics Department. Hence, of the six (6) Mathematics teachers at the school, only two (2) were formally trained. Teachers were supportive of the principal and were optimistic about the prospects of the school.

❖ *Students*

Most students were from the same educational, socio-economic and cultural settings. Many possessed limited educational resources due to the economic conditions within the community. However, some were clearly more advanced than others in terms of their cognitive potentials. Most students found comfort in communicating in a second language (Cocoye), which was the dominant language within that community.

❖ *Classroom setting*

The classroom setting was in a traditional arrangement, with students sitting in distinct rows facing the teacher who mainly instructed them through expository type lessons from the front of the room. There was usually a remarkable level of silence and a fairly good level of discipline during school hours. There were limited teaching resources in the classrooms and students took along the basic materials that they would require during lessons.

❖ *School performance*

Based on information on school performance on the island over the past years, the school has had a history of good performance (Henry 2002). As such, in past years parents registered their children at this secondary school as opposed to other neighbouring schools.

4.4.1: Teachers' profiles (School A)

A profile of each of the teachers of **School A** was prepared so as to obtain a clearer explanation of teachers' actions during the intervention programme Table 4.0.

TEACHER CODE	POSITION	EXPERIENCE	TRAINING
1AM	Head of Department	10 years	Certificate in Education
2AM	Classroom teacher	2 years	None
3AM	Classroom teacher	3 years	None
4AF	Classroom teacher	2 years	None
5AM	Classroom teacher	6 years	Associate degree
6AF	Classroom teacher	4 years	None

Table 4.0: Teachers profile (School A)

The teachers of this school were sub-divided into categories based on training and experience (Table 4.1). Hence, the following four categories were established:

- *Teachers with 1-5 years experience with formal training*
- *Teachers with 1-5 years experience with **NO** formal training*
- *Teachers with 6-10 years experience with formal training*
- *Teachers with 6-10 years experience with **NO** formal training.*

The following is a categorisation of teachers based on teacher training and experience.

TEACHER TRAINING AND EXPERIENCE			
1-5 years with formal training	**1-5 years with NO formal training**	**6-10 years with formal training**	**6-10 years with NO formal training**
-	**2AM**	**1AM**	-
-	**3AM**	**5AM**	-
-	**4AF**		-
-	**6AF**		

Table 4.1: Categorising teachers of *School A* based on training and experience

4.5: Pre-intervention interviews (School A)

An informal rapport prior to the practical research activity revealed that teachers were all enthusiastic about the teaching of thinking. However, inexperienced teachers were slightly sceptical since they felt that they were not confident enough to embark on an innovation of this nature (*See field notes, Appendix R*). The following represents pre-intervention interview responses from **School A.**

❖ *Beliefs on teaching*

The teachers were asked to give their perceptions on how Mathematics should be taught and learnt. Based on their responses, it appeared that Teachers **1AM**, **3AM** and **5AM** shared similar beliefs. Teacher **1AM** indicated, '*because of the nature of Mathematics, these lessons should be interactive*'. He believed '*...students should be given opportunities...to figure out things for themselves...*' Teacher **3AM** suggested that Mathematics teaching '*...should be all about activities*'. He further noted that '*...the teacher should make sure that the lessons are fun and not stressful so that kids will realise that the subject is one that they can do*'.

Teacher **5AM** added that '*Mathematics teaching should be as creative as possible*' and '*...the teacher should make the subject matter as interesting as possible*'. The teacher further argued that '*...showing students how the subject is related to the real world and how important it is for everyday life*' could maintain creativity and interest.

The responses of Teachers **1AM** and **5AM** seemed to indicate a social constructivist view of Mathematics teaching in the sense that the teachers appreciated the importance of interaction and autonomy in the Mathematics classroom. This response might have been due to the fact that these teachers were formally trained on effective teaching and learning strategies. However, it was of interest that, although untrained, Teacher **3AM** held similar perceptions in his view that Mathematics teaching and learning should be centred on more progressive approaches.

Unlike Teachers **1AM, 3AM** and **5AM,** Teachers **2AM, 4AF** and **6AF** stressed the importance of demonstration and practice in the Mathematics classroom. Teacher **2AM** suggested that Mathematics teaching *'...should involve a lot of practice...'* and *'...kids should be given strategies to work problems and to use easier and faster techniques to get the correct answers'.* The teacher's main reason for such belief was the fact that it assisted in *'...keeping students under control in terms of discipline and in seeing who the troublemakers are...'*

The fact that a strategy was primarily used for its ability to keep students under control as opposed to its effectiveness in fostering learning was interesting but not surprising since in many instances inexperienced teachers, are more concerned with other school factors such as maintaining order and discipline in the classroom as opposed to student learning. Teacher **2AM** further supported this argument in his admission that *'...it is hard enough getting through a day without behaviour problems so I have to ensure that each day of teaching is as problem free as possible'.*

Teacher **4AF,** added that *'...in order to be good at Mathematics, you have to practice and work out faster ways of doing things all the time.* He argued that *'Math is intellectually demanding so students have to realise that they have to think more for Mathematics than for other subjects'.* He was of the opinion that *'...Mathematics is all about formulas and if you are not told or don't know the formula to solve the problem, then you are lost'.*

Teacher **6AF** shared similar sentiments in her view that *'...Maths should involve a lot of practice in the things that the kids should learn.'* She appeared to be in strong agreement with

Teacher **4AF** on the issue of memorising formulas in her contention that '*...the teacher should ensure that the children...have strategies to remember the formulas that they can use in exams'.*

The issue of challenge was also addressed and it was of interest that the teachers thought students should be challenged in the classroom. However, they felt that under the current classroom conditions, it was not practical to further challenge students. This would probably mean teachers rarely used challenge in the classroom. Teacher **1AM** suggested '*...students on a whole are lazy...*' and '*...they are just not thinking, let alone more challenge'.* Upon further questioning, it appeared that most teachers had a limited conception of the meaning of challenge since they equated difficulty with challenge. This was reflected by Teacher **2AM** in his claims that students '*...hate Mathematics because it is difficult and that is challenge enough*'. The teacher suggested that challenging was not possible since '*local and regional examinations require specific formulas*'...leaving students with '*...no room for creativity'.*

Teacher **3AM** on the question of challenge, suggested '*...if you challenge students too much...then they can get frustrated or stressed out and that's what makes them hate Mathematics'.* The teacher added '*...most of the students complain that it is too difficult...and would not choose Mathematics as a subject if they had the choice'.* Teacher **5AM** was of the view that '*...when the work gets the least bit challenging...'* students '*...begin to complain that the work is too difficult and start skipping classes...*'

Teacher **4AF** felt that '*Maths is naturally challenging and therefore students have to live up to the challenge*'. However, she believed that '*...a lot of the students do not have the level of*

thinking that is required for Mathematics...' According to the teacher, challenging lessons are good but '*...they cause the students to stray from the topic...'* She indicated that if the teacher follows that path, he or she *'...will never complete anything within the given time.'* According to teacher **6AF,** with challenging lessons, the teacher has '*...to be prepared to deviate from the lesson because students tell you stuff that you don't really want to get into...'* She claimed that the students '*...tend to lose focus and before you get the answer that you are looking for, the period is over'.*

❖ *Teaching Practice*

Teachers were asked to comment on teaching practice and all indicated that they mainly used 'whole class, direct instruction' during normal lessons. Teacher **1AM** indicated that although some of his normal lessons were to some extent interactive, he would mainly '*...explain and demonstrate and then give some practice in the concepts explained'.* It was interesting that the teacher's practices did not reflect his beliefs on the teaching and learning of Mathematics.

Like teacher **1AM,** Teacher **2AM** indicated that he would '*...give students examples and have them do some on the board'.* It was also evident that the teacher relied to some extent on drilling in his method of having students '*...practice formulas...'* and then *'...do as many as they can to master the concept'.* The current practice of Teacher **2AM** was in line with his beliefs on teaching

Teacher **3AM** used a slightly different method in that he tried to '*...ensure that students are always engaged*'. He felt that they have to be active, '*...or else they will lose interest.*'

However he admitted that this was not always possible due to the current teaching context. Teacher **4AF** indicated that she allowed students to '*...do more on their own after they have been shown how to do it...*' This practice was, to a certain extent, related to her beliefs on the teaching and learning of Mathematics.

Teacher **5AM** suggested that on occasions he would try to make his lessons '*...interactive and stimulating'*. However, he conceded '*...that could be time consuming and costly at times because you need added materials, which at times can only be purchased*'. He claimed that interactive lessons were delivered '*...as a treat...and they...*' [the students] '*...seem to enjoy it'*. However, he admitted that could not be done on a daily basis since one would '*...run out of time to complete the syllabus'*. Teacher **6AF** acknowledged that she used'*...different approaches if someone comes to teach a different strategy'*. She claimed that she usually '*...modelled the solutions to problems and then gave the kids practice in doing similar problems.*'

It was worth noting that although Teachers **1AM, 3AM** and **5AM** believed that interactive and practical approaches were the ideal, they were not practiced in the classroom on a regular basis. On the other hand, Teachers **2AM, 4AF** and **6AF** appeared to base instruction on demonstration and repeated practice, which seemed to be in line with their beliefs on teaching. It was also of interest that the teachers had different ways of catering for students with varied abilities. Teachers **1AM** and **2AM** and **4AF** did not specifically cater for differences in students' abilities since they '*...pitched the lesson at the average...*' with the hope that '*...all students would at least get something from the lesson'*. The teachers felt that students would

not all get the same thing but they would all pick up something at some point. According to Teacher **4AF**, '*...the average and brighter ones will get more from the lesson most of the times...*' but her defence was that '*...one group will always benefit more than others.*'

Teacher **3AM, 5AM** and **6AF** appeared to use an individualised approach since they would work with students on an individual basis after a period of whole class activity. They however admitted that due to class size and time constraints, it was impossible to concentrate on those with problems because '*...the teacher might end up ignoring the others and spending too much time on one lesson.*'

In order to determine whether the teachers' utilised varied teaching approaches, they were asked to comment on the use of small group activities in the classroom. Teachers were generally not in favour of small group activity as an instructional approach. Teachers **1AM** and **2AM** felt that this approach was suitable for small classes where the teacher has the luxury of time and space. Teacher **1AM** claimed '*...small group activities are beneficial but the teacher must be trained on how to manage students in groups*'. Teacher **3AM** suggested '*...the kids considered small group activities as a time to play*'... and '*...they don't see group work as a learning exercise.*'

Teacher **4AF** added that small group activities are beneficial only in terms of developing '*...some social things like co-operation and sharing*'. She thought that with such activities '*...it is difficult to tell what individual students can do.*' Teacher **5AM** was of the view that such activities '*...are beneficial but the teacher must know what he or she is looking for or*

wants to get from students'. Teacher **6AF** shared similar sentiments with Teacher **4AF** in her view that students '*...waste a lot of time and you can hardly control them when they are working in small groups'*. She concluded that '*...they seem to use that as an opportunity to do things without the teacher seeing them.*'

The teachers' dislike for small group activity could possibly be attributed to the fact that such approach requires a greater degree of students autonomy and teachers might have been more concerned with maintaining their dominance in a traditionally 'safe' and 'controlled' classroom atmosphere rather than venturing into what they viewed as potentially 'uncontrollable' learning environments. In addition, in many instances teachers indicated that they were not adequately trained in this strategy to the point where they could make a positive impact on students learning.

All the teachers felt comfortable with 'whole class direct instruction' since they considered this approach as a guaranteed way of completing the syllabus. It was worth noting the claims of Teacher **1AM** that '*...90% of the time it does not work in the long run*'. The teacher conceded '*...we know that a lot of the times whole class teaching does not work. Why we continue with it, I don't know*'. All teachers shared similar viewpoints on the advantages of whole class teaching. According to Teacher **2AM,** '*...the syllabus is completed much faster...'* using whole class direct instruction. He suggested that adopting a whole class teaching approach also '*...takes care of discipline problems because the teacher has full view and is in full control.*' Teacher **3AM** added that '*whole class teaching works well...'* since the teacher has *'...more control over pace of the lesson and the behaviour of students.'* He claimed that *'the*

teacher can plan better because things are more predictable.' However, like Teacher **1AM**, he conceded that *'...students sometimes forget the stuff'* [meaning the content of the lesson].

Teacher **4AF** supported the above views in her perception that with this method, *'...the teacher can cover more of the content within the given time...and cannot stray from the objective'*. The teacher also regarded this approach as an aid to classroom management in her belief that with whole class teaching the teacher *'...checks on the misbehaving students so that they behave themselves.'*

Teacher **5AM** suggested that whole class teaching *'...has its time and place'*. He acknowledged it was not the best for student learning but indicated *'...in the current educational environment, there was not much else that a teacher could use'*. Teacher **6AF** claimed the approach *'...works well for the average child...'*

The fact that the school syllabus has to be completed within a specified time generated interest since it would indicate that this was one of the teachers' goals. It should also be noted that this goal was of some importance to the teachers, since it appeared as one of the influential factors in determining their teaching approach. The latter argument was further supported by the claims of Teacher **6AF** that *'...everything is about completing the curriculum and covering the contents for examinations so the teacher has to use the fastest way.'* It was also apparent that some of the teachers, particularly the inexperienced, had no in-depth exposure to other methods because when asked whether they frequently used other teaching approaches besides whole class teaching, they replied that they were not very familiar with the other teaching approaches.

❖ *Professionalism and Professional growth*

The issue of improving practice over time was addressed since it was felt that this was one of the attributes of a 'true professional'. All teachers indicated that their practices improved in some way with the passage of time. Teacher **1AM** acknowledged learning from his mistakes and *'...looking at things from a different perspective each time'*. Such quality he attributed to his training since his current beliefs were '*...non-existent before training'*.

When asked whether his teaching improved over time, Teacher **2AM** acknowledged '*...learning from his mistakes over the past year...'* since he '*...always tried to perform much better with the next class*'. However, he was concerned that '*...each class is different and as such a strategy may work well for one group of students and not for the next...'* Teacher **3AM** claimed '*...if something works well for a group, you know that you can try it with the next group and it may work well for them also.'* However, like Teacher **2AM,** he conceded *'...teaching is very unpredictable and what you expect to happen rarely does'*. Teacher **4AF** was of the view that that she '*...gets more comfortable as time goes by.*' She admitted that she '*...survives teaching on a day-to-day basis...'* but she '*...feels more confident'* day by day.

Teacher **5AM** indicated that he gets better at teaching all the time by attending courses and talking to others so that he learns more. The teacher's statement appeared to point towards awareness of the fact that learning is a continuous activity and that the classroom should be a learning environment for everyone. This argument was succinctly presented in the following confession:

'*...I mean even if there are only two of us trained in here, I still learn from the others who are not trained. There is always something that someone can contribute. I mean, I learn from the kids too. You are never too old to learn. I still make mistakes and I try to learn from them. I mean who doesn't? Teaching is about learning and there is no doubt about that; learning for the teacher, learning for the kids*'.

Teacher **6AF** also felt her confidence was gradually improving. She concluded that she feels more '*...confident with exploring new strategies...*' as she gains more experience. One interesting acknowledgement was teachers' perceptions that students do not have as much respect for the capabilities of new teachers; a factor that they think affects the confidence of new teachers in the classroom.

Teachers' Reflection on practice

The issue of reflection on practice was addressed when teachers were asked to relate instances where they took time to sit back and think of the successes and limitations of past lessons. Teacher **1AM** responded '*...I do that all the time, even though not in writing*'. He considered reflection as an integral component of his job as a Head of Department and did not think the other teachers would have the '*...luxury...*' of reflecting even if they knew how to do it. He admitted that he did not reflect on a daily basis but he did, on occasions, at the end of the week.

Teachers **2AM, 3AM** and **4AF** claimed that they rarely reflect on practice since there is too much to do in a school day. Teacher **2AM** admitted that he only reflected '*...if a lesson was really, really bad*'. Teacher **3AM** also equated reflection with looking at ones mistakes in his question '*who wants to remember their mistakes?*' Like teacher **2AM**, he suggested that '*...if*

something terrible happens then you try to prevent it from reoccurring but if you only think of your mistakes, then you will leave the job quickly.' Teacher **4AF** held the view that it is '*...hard to think back on anything when the day is so packed*'. She insisted that '*...dealing with students on a daily basis is a workload and that leaves time for little else.*' It was interesting that although Teacher **5AM** claimed to actively reflect on practice, during reflection he considered a number of factors that were not necessarily related to student learning. As indicated by the teacher;

> '*I often think about my role as a teacher and my role as a staff member. There are so many negative things out there like the little pay and lack of respect for teachers and all that. You sometimes think that you don't worry about what happens in the classroom but at the same time something eats at you from inside and you ask yourself, am I doing a good job? Is it fair to the kids? I mean who does not have a conscience? You have to think and try to make it better, you just have to*'.

Teacher **6AF** claimed that on occasions she thought about her teaching and students' subsequent learning but conceded that she '*...rarely reflected on practice since time was limited'*. One could conclude that most of the inexperienced teachers felt they hardly had time to reflect due to the pressures of coping with daily classroom activities. However, experienced teachers appeared to reflect more frequently. The fact that some teachers rarely reflected might have meant that they were not in a position to open themselves to a critical look at successes and limitations and therefore might have missed opportunities for professional growth.

Opportunities for growth in practice also occur through collaboration with critical peers and therefore, teachers were asked whether they shared classroom experiences with colleagues

during the school term. All teachers claimed that they collaborated to some extent. Teacher **1AM** responded;

> '*...there is something in place. We do help each other on occasions. If any teacher has a problem all they have to do is ask and we are there to assist. They are free to talk about their lessons and their successes and areas of weakness. We have that open communication environment'.*

Teacher **2AM** claimed '*...we always share materials at times. We also talk about problem cases and difficult parents'.* This response was interesting since it meant that collaboration might have been on a surface level in terms of sharing materials but not at the intellectual level, which is needed for sustained growth in practice. Teacher **3AM** added '*we talk about the kids who perform well or those who are excessively problematic'.*

Teacher **4AF** attempted to use collaboration for effective teaching in her statement '*...I try to ask for help by telling the other teachers... when things go wrong.*' It was interesting that this teacher indicated '*...the more experienced teachers talked about different things than the new ones.*' She admitted '*...new ones talked about problems with kids and so on but the older and more experienced ones talked about things in which we are not so interested.*' When asked what sort of things the more experienced teachers talked about, she responded, '*...things related to the running of the school.*'

On the issue of collaboration, Teacher **5AM** responded '*...we talked about everything. We talked about the school, the kids, the lessons at times and so on'.* He suggested that he would have liked more opportunities to collaborate but the opportunity to do this was not readily available due to time constraints. Teacher **6AF** was in agreement with the previous teachers in

her suggestion that they '*...talked about general issues...things about children with problems, test results and so on but not necessarily about actual teaching itself*'.

Based on the responses of teachers, one could conclude that there appeared to be some level of communication among the Department's staff but they appeared not to have a common view as to what was most relevant during staff collaboration.

❖ *Teachers' accounts of students' attitudes to their teaching*

A series of questions were asked in an effort to solicit teachers' perception of students' responses to their teaching. Teachers were asked to characterise students' behaviour in terms of their level of interaction during regular Mathematics sessions. Most teachers felt that students interacted on a 'student to teacher' level and on most occasions, student interaction would be about issues not relating to the lesson.

Teacher **2AM** indicated '...students will only think if the lesson is interested...' According to Teacher **3AM,** '...if you give them a chance they will talk and talk but not about the lesson contents, that's why the teacher has to be in control.' Teacher **4AF** added '...whenever you give them an exercise, they have to spend some time talking before they can get down to do the work'. Teacher **6AF** claimed '*...most times they begin talking even before the attempt to answer the questions.*' The fact that these teachers view students conversing as a negative aspect of classroom learning is essential since it is probably one of the factors influencing the hidden but flawed notion among many Dominican teachers, that quiet classrooms are the only ones conducive to student learning.

When asked to comment on the nature of students' responses to questions, teachers had differing viewpoints. Teacher **1AM** felt that students' responded

> '*...based on how they understand things and most times they don't clearly understand things so they give it to you*' [the teacher] '*as they understand it, which is often not what the teacher is expecting*'.

The teacher indicated that students were '*...very spontaneous...*' since they rarely thought of the responses that they were about to give. He however admitted such quality might have been due to teachers' methods of questioning since they have the tendency to rush students into answering questions and '*...not giving them adequate thinking time'*.

Teacher **2AM, 3AM, 4AF** and **5AM** indicated that students' responses in regular classes are '*...often brief...*' and as such they frequently asked students to '*...explain what they meant'*. Teacher **2AM** felt that students rarely challenge others' responses since '*...they accepted as correct everything anybody says*...' According to Teacher **3AM,** the teacher has to be at students all the time to explain since '*...most of the time they only want to give yes or no...*' answers. Teacher **4AF** indicated that students only give the '*...shortest possible answer*'... and that *'...they think about the contents of the lesson only when they are threatened with a test.'* The fact that the teacher uses a test to threaten students into learning Mathematics might have probably meant that students might have a view of Mathematics learning as distressing experience. One could also conclude that there seemed to be a misunderstanding of the real purpose of testing.

Teacher **5AM** suggested that students' responses varied based on their mood and their level of interest in the lesson. He felt that students had a limited retention span since they often forgot

the contents of the lesson within a relatively short space of time. The above attributes seem to be typical of traditional settings since students are not sufficiently exposed to the level of independence that they require for effective learning.

Teacher **6AF** admitted to probing students to get them to tell why they think a particular answer is correct. The teacher claimed '*...students rarely challenged the contributions of others*' and therefore the teacher has to '*...drag the contributions out of them...*' She suggested '*...when the teacher offers them something in return, then they are more likely to participate*'. It must be noted that the method of rewarding students for good performance as indicated by Teacher **6AF,** might have been much more appropriate than that of threatening students with a test as suggested by Teacher **4AF.**

4.5.1: Summarising pre-intervention interview responses (School A)

The following is a summary of pre-intervention interview responses

MAJOR ISSUES	SUMMARY OF RESPONSES.
Beliefs	Teaching should involve lots of practice. Lessons should be interactive. The teacher should give students strategies and formulas to help them solve problems. The teacher should show students easier and faster techniques to get the correct answer. Lessons should be as creative and interesting as possible. Lessons should be contextualised and related to the real world.
Practice	Explains, demonstrates and then give some practice on the board. Ensuring that students are engaged. Direct instruction with mainly explanations. Pitching the lesson at the average level.
Professionalism & professional growth	Informally reflects on practice. Provides opportunities for other teachers to discuss issues relating to teaching and learning. Rarely reflects on practice due to lack of time and lack of knowledge of reflection. Reflects only in cases where something went really wrong. Survives teaching on a day-to-day basis but feels confident as time goes by. Learns from mistakes and always tries to perform better. Collaborate on issues relating to difficult learners or those who excel.
Teachers' accounts of students' attitudes to their teaching	Students interact with peers but on issues not relevant to the topic being discussed. Students interact on a student teacher level. Students will only think if the lesson is interesting or when they are threatened with a test. Students' responses are often brief and they accept whatever is suggested. Students are spontaneous. They provide brief responses and rarely think about their thinking.

Table 4.2: A summary pre-intervention interview responses (School A)

From the above, it could be concluded that although there was a variety of perceptions as to what constituted effective teaching and learning, there seemed to have been uniformity in practice since all teachers used, what could be termed a traditional teaching approach. Interviews revealed that, although all teachers were embarking upon steps to improve practice, some reflected on practice more frequently than others. In addition, students' responses appeared similar in all cases.

4.6: Teachers' journals *(School A)*

The data collected from teachers' journals were analysed through the identification of emerging themes. This involved the identification of common or unique features as well as the relationships among these features. Analysis of journal entries substantiate the fact that teachers' reflections were not directly related to the guidelines provided for self-reflection (*Appendix G*). It was expected that teachers would look mainly at 'teacher related' factors as they impacted on the delivery of thinking lessons. However, there were as many entries relating to the thinking lessons themselves or to students' responses to the lessons as teacher related issues.

A detailed analysis of the journals, revealed a number of recurrent themes. Based on journal entries, emerging themes were divided into two major categories namely, issues during the *first* and *second* phases of implementation. The first phase of implementation involved thinking lessons taught during *term two* of the school year, while the second phase involved thinking lessons taught during *term three.* These categories were necessary to illustrate potential differences in teachers' accounts of the lessons delivered at various points during the research

process. The following Table represents the emerging themes and relevant categories from the journal entries.

THEMES EMERGING DURING THE FIRST PHASE OF IMPLEMENTATION	THEMES EMERGING DURING THE SECOND PHASE OF IMPLEMENTATION
Detailed preparation did not necessarily result in smooth lesson delivery. *Group activities were problematic due to students' unfamiliarity with group work.* *Group activities brought added classroom management problems.* *Delivery of thinking lessons required a greater degree of teacher preparation.* *Delivery of thinking lessons was time consuming.* *A greater proportion of open-ended questions meant the potential for loss of focus.* *Some lessons had to be modified to suit the context and ability of students.* *There were instances of teacher unease about lesson delivery.* *The lesson appeared challenging since teachers had to be constantly on guard in order to ensure that students were fully engaged.* *Some students had difficulty in responding to open-ended questions.* *The structured nature of lesson plans meant that too much time was spent on familiarisation before lesson delivery.* *Thinking lessons were practical and related to real life experiences.*	*There were improvements in teachers' questioning skills.* *Students exhibited greater interest during thinking lessons.* *Lesson delivery was more successful where teachers felt comfortable with the topic.* *There was greater participation among weaker students during thinking lessons.* *Increasing praise resulted in a subsequent increase in students' responses.* *As lessons progressed, students were more receptive to small group activities.* *The use of small group activity meant limited evidence of individual learning.* *Students enjoyed using their own strategies to solve problems* *Lessons raised teachers' awareness of how best to cater for varying abilities.* *Thinking lessons assisted in enhancing the level of collaboration among staff.* *Group activities that were well planned were more successful.* *There were less classroom management problems when students were engaged.* *Some students had problems in understanding activity sheets.* *Group work was not always practical due to limited classroom space* *Some of the teaching techniques used during thinking lessons were also used in normal Mathematics lessons.*

Table 4.3: Summary of emerging themes during implementation of thinking lessons (School A)

From the themes presented above, a number of conclusions could be made. Detailed analysis of teachers' entries reflected a degree of pessimism on the part of teachers during the *first phase* of the intervention. Although there were some positive entries during the *first phase*, there was a greater proportion of negative entries. Some of these include:

- *The problematic nature of small groups activities*
- *The fact that detailed preparation did not necessarily result in smooth lesson delivery.*
- *Excessive time spent on familiarisation before lesson delivery.*
- *The time consuming nature of thinking lessons.*
- *Teacher unease about lesson delivery.*
- *The potential for loss of focus due to a greater proportion of open-ended questions*

However, there appeared to be a shift in teachers' overall impressions of the lessons as reflected in the *second phase* of implementation. This was characterised by a greater proportion of positive entries as opposed to negative ones. Some of these entries include:

- *The fact that students grew in terms of their receptivity to small group activities*
- *Improvement in teachers' questioning skills and in recognising students' contributions*
- *Students exhibited greater interest in learning Maths.*
- *A higher level of participation among weaker students*
- *Teaching techniques used during thinking lessons were also used in normal lessons*
- *Increasing praise to students resulted in a subsequent increase in students' responses.*
- *Students enjoyed using their own strategies to solve problems*
- *Lessons helped raise teachers' awareness of how best to cater for varying abilities.*
- *There were less classroom management problems when students were engaged*

In an effort to further analyse the data, emerging themes were further divided into three sub-categories namely, those representing some aspect of *teacher development*, those representing some aspect of *students' responses* and those representing the *contents of thinking lessons.* Issues representing *teacher development* focussed mainly on teacher related functions such as professional growth, reflection and potential changes in practice. Issues related to *students'*

responses considered potential changes in students' behaviour during lessons as it relates to improved learning skills or cognitive competencies. Finally, issues relating to *the contents of thinking lessons* considered teachers' impressions of the contents of thinking lessons based on lesson delivery (Table 4.4).

ISSSUES REPRESENTING TEACHER DEVELOPMENT	ISSUES REPRESENTING STUDENTS' RESPONSES	ISSUES REPRESENTING LESSON CONTENTS
Lesson delivery required a greater degree of teacher preparation *Detailed preparation did not necessarily result in smooth lesson delivery* *There were added classroom management problems brought about by small group activities.* *A greater proportion of open-ended questions meant the potential for greater loss of focus.* *There were instances of teacher unease about lesson delivery.* *The lesson appeared challenging since the teacher had to be constantly on guard to ensure that students were fully engaged* *Lesson delivery was more successful where teachers felt comfortable with the topic* *There were improvements in teachers questioning skills.* *Thinking lessons assisted in enhancing the level of collaboration among staff.* *Group activities that were well planned were more successful* *Some of the teaching techniques used during thinking lessons were transferred to normal Mathematics lessons* **Thinking lessons raised teachers' awareness of how best to cater for varying abilities*	*Some student had difficulty in responding to open-ended questions.* *Having students work in small groups was problematic due to students' unfamiliarity with group work* **Some students had problems understanding activity sheets.* *Students exhibited greater interest in learning Mathematics during thinking lessons.* *There was greater participation among weaker students during thinking lessons.* *As lessons progressed students were more receptive to small group activities* *The use of small group activity meant limited evidence of individual learning.* *Students enjoyed using their own strategies to solve problems* *Increasing praise to students resulted in a subsequent increase in students responses* *There were less classroom management problems in lessons where students were fully engaged.*	*Some lessons had to be modified to suit the ability of students.* *The structured nature of lesson plans meant that too much time was spent on familiarisation before lesson delivery.* *Thinking lessons were practical and related to real life experiences.* **Some students had problems understanding activity sheets.* *Group work was not always practical due to limited classroom space* **Thinking lessons raised teachers' awareness of how best to cater for varying abilities*

* *Entries requiring dual categorisation*

Table 4.4: Sub-categorisation of emerging themes from teachers' journals (School A)

4.6.1: Summarising categories of emerging themes obtained from teachers' journals

❖ *Issues relating to teacher development*

It was interesting that many teachers were of the view that the strategies adopted during thinking lessons were beginning to influence regular instruction. In addition, the fact that there were improvements in teachers' questioning skills and in methods of praising students' responses meant that there was a greater potential for student learning. Further, teachers felt that the thinking lessons raised their awareness of how best to cater for varying abilities. This might have meant that teachers might have realised the fact that individual students have different instructional needs and should be treated as such.

❖ *Issues representing students responses*

There were also a number of interesting observations based on teachers' accounts of *students' responses*. The fact that students enjoyed using their own strategies to solve problems might have increased the potential for student autonomy and subsequently improved learning. In addition, one could argue that increased participation among weaker students would almost certainly lead to better school achievement. Further, the fact that there were less classroom management problems when students' were fully engaged, would suggest that contrary to teachers' initial beliefs, teacher dominance is not the sole method of obtaining class control.

❖ *Issues relating to lesson contents*

Based on the issues representing lesson contents, it was revealed that due to the structured nature of the lesson plans, teachers spent much more time than expected on familiarisation before lesson delivery. Hence, this might have acted as a deterrent to the degree of receptivity

among teachers. In addition, some lessons had to be adapted to suit students' ability and the educational context. This means that the lessons could not always be delivered as planned since the learning context was different from those where the approach was conceptualised. Further, many teachers expressed concern over the time consuming nature of thinking lessons. Since teachers consider time constraints as a major issue, their receptivity to such strategy might have also been influenced by its time consuming nature.

Teachers' accounts of thinking lessons were compared with the events during lesson delivery as reflected through lesson observations. The following section represents data collected form lesson observations.

4.7: Lesson observations *(School A)*

A series of lesson observations were made in order to determine the extent to which teachers' perceptions corresponded with their practices. Each teacher received a total of six lesson observations during the research period. Two lessons were observed *before* active intervention period, two were observed *during* active intervention period and two were further observed *after* a period of active intervention when the level of support was reduced. In an effort to simplify the data gathered from lesson observations, and to avoid premature conclusions based on a single instance of lesson observation, an average of occurrences for the two lessons during each phase of the intervention was calculated (*See Appendix S for a sample of raw data).* Where the resulting average included a fraction, the figure was rounded up to the next whole number.

Lesson observations focussed mainly on teacher related features and categories included both positive and negative aspects. Observations were divided into two categories namely, a structured component and a descriptive component (*Appendix N*). The structured component comprised the frequency of teacher related features. Descriptions, on the other hand, comprised a rating for various aspects of lesson delivery. For the purpose of data presentation, teacher related features during structured observation were abbreviated. The following is an interpretation of the codes presented. A full description of these features could be obtained in *Appendix M*.

CODE	*INTERPRETATION*
Open ended	The use of open ended questions
Closed	The use of closed questions
Probe	An attempt to probe deeper into the responses of students
Praise	Openly praising students for good responses
Challenge	Challenge the responses of students
Build	Build on the responses of students
Small group	Instances of small group activity

During the research process it was apparent that some teachers, although receptive to the innovation, felt that they had too many other functions to perform and this undoubtedly impeded their efficiency in the teaching of thinking lessons. This was particularly true to new teachers who were already pressured to perform what could be considered 'routine' teaching functions. The following represents an analysis of lesson observations for each teacher at **School A.**

Teacher 1AM

Structured observations revealed that Teacher **1AM** experienced marginal growth throughout the intervention (Figure 4.0). There was an increase in positive aspects of teaching such as *open-ended questions* and *praise to students* and *probing students' responses*, with a subsequent decrease in less desirable qualities such as *the use of closed questions*. The greatest degree of change was seen in an increase in the frequency of *probing responses* and in the use of *praise*.

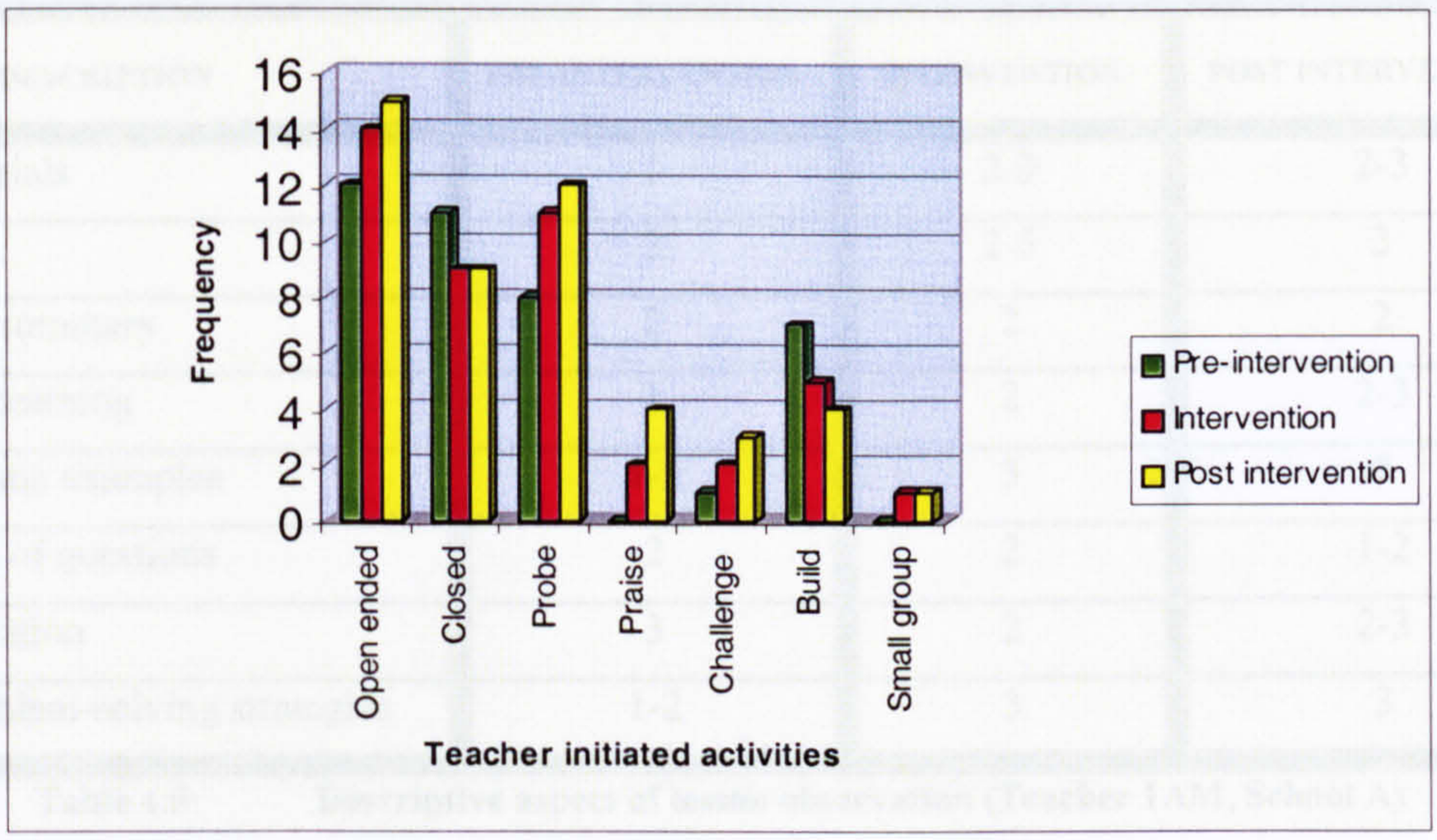

Figure 4.0: Structured observation results (Teacher 1AM, School A)

Structured observations were supplemented by a description of aspects of lesson delivery that could not be captured through such method. The teacher demonstrated 'average' performance in many aspects of lessons delivery at the pre-intervention phase but appeared to improve delivery at the intervention and post intervention phases (Table 4.5). During the pre-intervention phase the teacher *needed improvement* in two areas namely, *the use of materials* and *transfer of learning*. However, there was clear improvement in these aspects throughout

the observation period since the teacher maintained an 'average' to 'good' rating in all areas of delivery. It was interesting that the teacher obtained a 'good' rating in task explanation during the pre-intervention phase but his performance in this area was not as efficient during the active intervention period.

Key:

1	1-2	2	2-3	3
NEEDS IMPROVEMENT	**NEEDS IMPROVEMENT /AVERAGE**	**AVERAGE**	**AVERAGE/GOOD**	**GOOD**

DESCRIPTION	PRE-INTERVENTION	INTERVENTION	POST INTERVENTION
Use of materials	1	2-3	2-3
Introduction	2	2-3	3
Conclusion/summary	2	2	2
Transfer of learning	1	2	2-3
Use of realistic examples	1-2	3	3
Distribution of questions	2	2	1-2
Task explanation	3	2	2-3
Diverse problem-solving strategies	1-2	3	3

Table 4.5: Descriptive aspect of lesson observation (Teacher 1AM, School A)

Teacher 2AM

Teacher **2AM** has demonstrated moderate growth in lesson delivery between pre-intervention and intervention phases (Figure 4.1). However, the differences between intervention and post intervention were of interest since, although this teacher maintained an improvement over pre-intervention lesson delivery, there was hardly any growth at the post-intervention period when compared to the intervention period. The greatest degree of change was seen in an increase in the level of *praise to students'* responses. There was also a notable reduction in instances of *closed questions* at the intervention and post intervention periods.

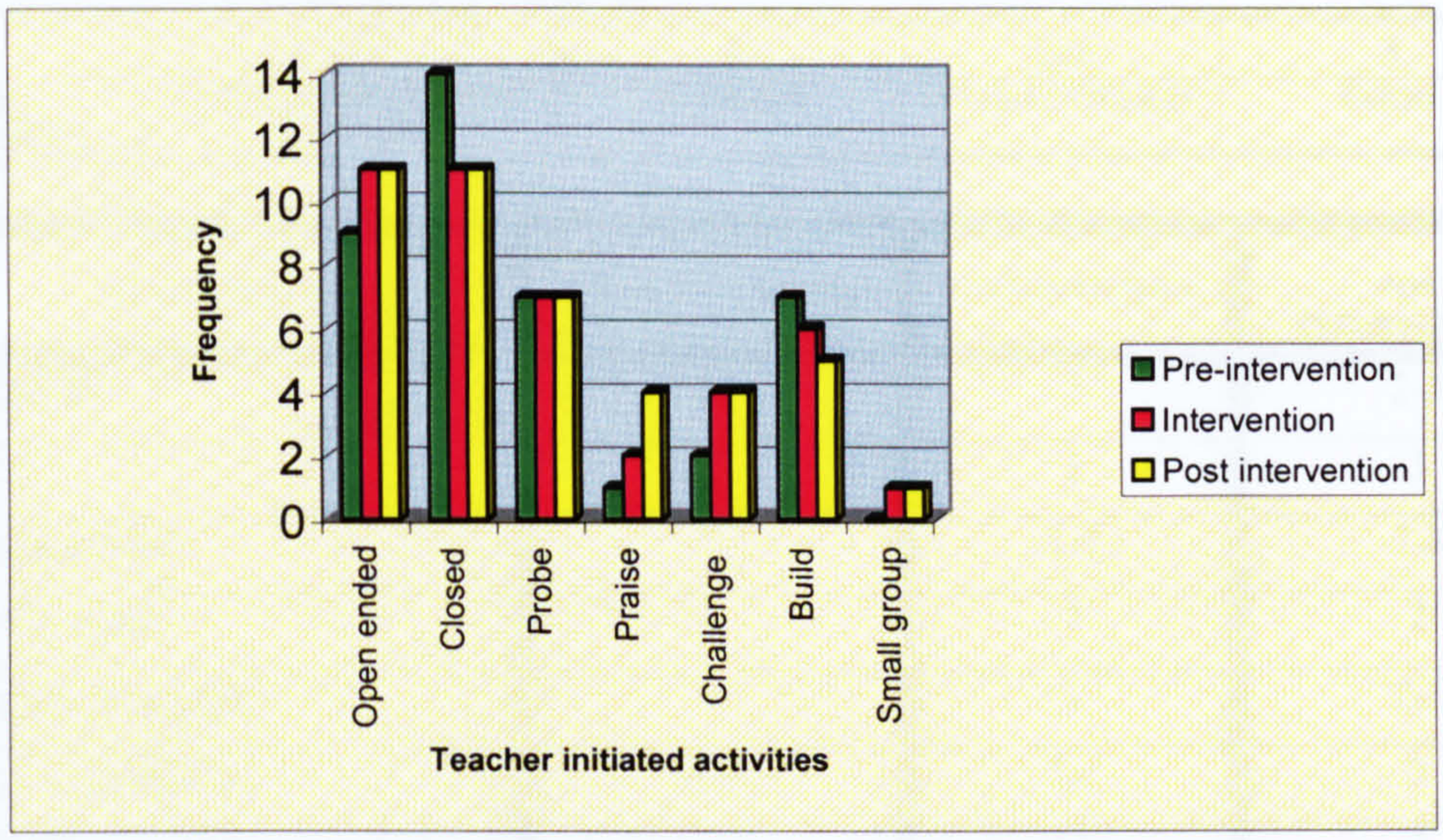

Figure 4.1: Structured observation results (Teacher 2AM, School A)

The qualitative aspects of the lesson delivery revealed a similar pattern in the features observe.

At the pre-intervention phase, the teacher 'needed improvement' in many aspects of delivery including the areas of *lesson conclusion, transfer of learning* and *the use of realistic examples* during teaching. However, he appeared efficient in *task explanation* and *distributing questions among the class*. The fact that the teacher excelled in the area of task explanation was not particularly surprising since it is one of the dominant features of direct instruction, an approach commonly used by the teachers at this school. As see in structured aspect of lesson delivery, Teacher **2AM** made some progress during the active intervention period and this was reflected in 'average' and 'good' ratings for most aspects of delivery (Table 4.6). However, there was limited growth at the post intervention phase.

Key:

1	1-2	2	2-3	3
NEEDS IMPROVEMENT	NEEDS IMPROVEMENT /AVERAGE	AVERAGE	AVERAGE/GOOD	GOOD

DESCRIPTION	PRE-INTERVENTION	INTERVENTION	POST INTERVENTION
Use of materials	1-2	3	2-3
Introduction	2	3	3
Conclusion/summary	1	1-3	2-3
Transfer of learning	1	2	2
Use of realistic examples	1	2	2-3
Distribution of questions	2-3	2-3	2
Task explanation	2-3	1-2	2
Diverse problem-solving strategies	2	2	3

Table 4.6: Descriptive aspect of lesson observation (Teacher 2AM, School A)

Teacher 3AM

Like Teacher **1AM**, this teacher has demonstrated constant improvement across all three phases of the research study, although such improvement was marginal (Figure 4.2). There was a notable decrease in the use of closed questions and a distinct change in the frequency of praise to students from the pre-intervention to the post intervention phase. As seen with prior lessons, there was no instance of small group activity at the pre-intervention period but a slight increase at intervention and post intervention periods.

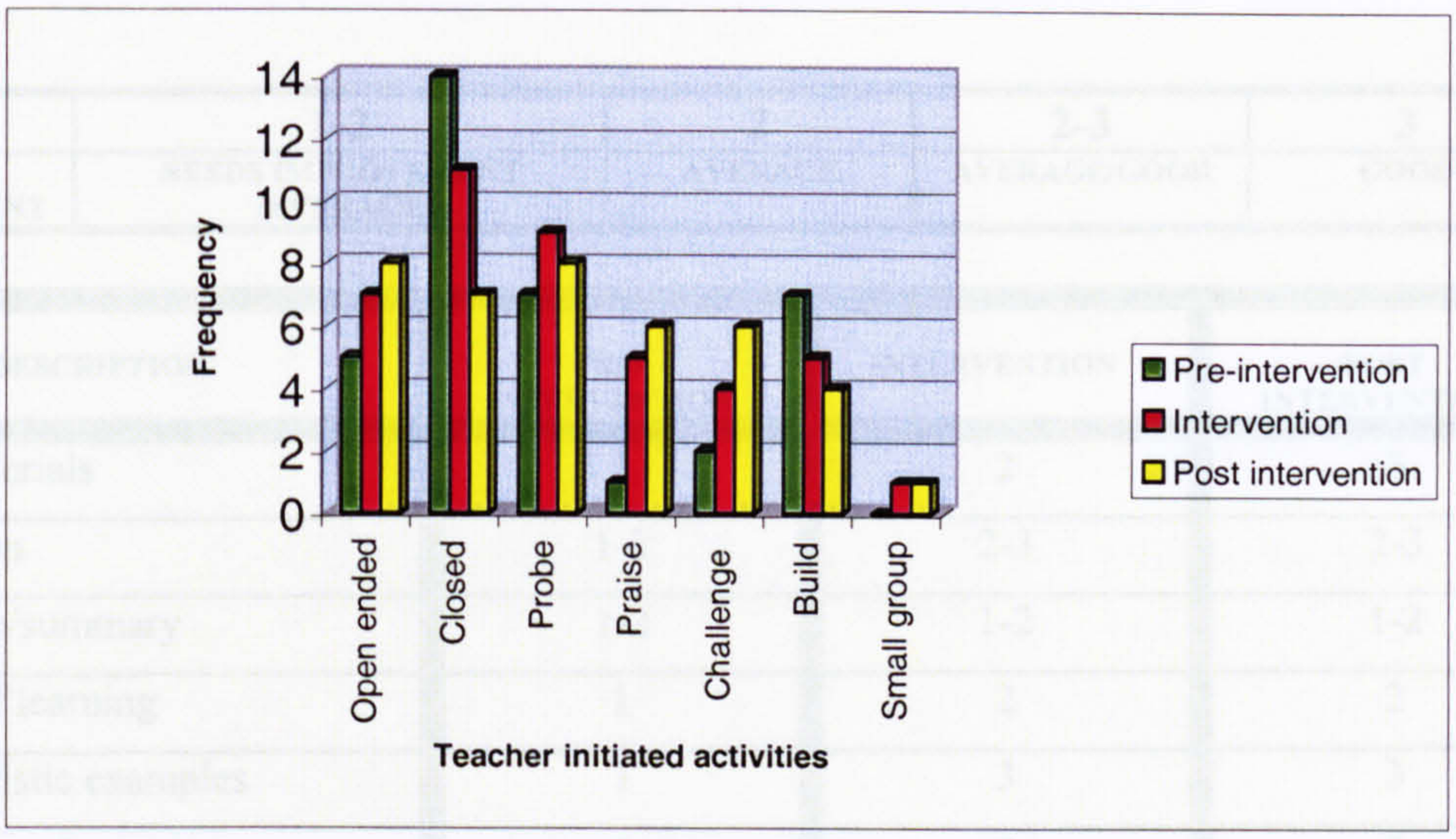

Figure 4.2: Structured observation results (Teacher 3AM, School A)

The descriptive aspect also revealed improvement in lesson delivery (Table 4.7). During the pre-intervention phase, the teacher 'needed improvement' in many aspects of delivery. These included *the use of teaching materials*, *transfer of learning* and *the use of realistic examples*. However, at the intervention and post intervention phases, the teacher maintained 'average' to 'good' rating in these categories. It was interesting that the teacher obtained 'average' to 'good' rating in *task explanation* at the pre-intervention phase but 'needed improvement' in this area during intervention. This might have been due to the fact that while direct instruction makes explicit use explanations, the thinking lessons were not as easy to explain since the teacher might not have been totally familiar with the structure of the lessons.

Key:

1	1-2	2	2-3	3
NEEDS IMPROVEMENT	**NEEDS IMPROVEMENT /AVERAGE**	**AVERAGE**	**AVERAGE/GOOD**	**GOOD**

DESCRIPTION	PRE-INTERVENTION	INTERVENTION	POST INTERVENTION
Use of materials	1	2	3
Introduction	1-2	2-3	2-3
Conclusion/summary	1-2	1-2	1-2
Transfer of learning	1	2	2
Use of realistic examples	1	3	3
Distribution of questions	2	2	3
Task explanation	2-3	1	3
Diverse problem-solving strategies	1-2	2	2-3

Table 4.7: Descriptive aspect of lesson observation (Teacher 3AM, School A)

Teacher 4AF

Teacher **4AF** has demonstrated change in practice over the three phases of intervention with a greater degree of change between pre-intervention and intervention phases (Figure 4.3). During the three phases of research there was an increase in the frequency of open-ended questions coupled with a simultaneous decrease in the frequency of closed questions. The greatest degree of change could be seen in a rise in instances of praise to students from the pre-intervention to the post intervention period. There was also change in the frequency of probing students' responses from pre-intervention to post intervention periods. In addition, there was a reduction in instances of building on responses. The reduction in instances of building on responses could probably be attributed to an increase in students' explanations and a subsequent decrease in the teacher's need to build on responses.

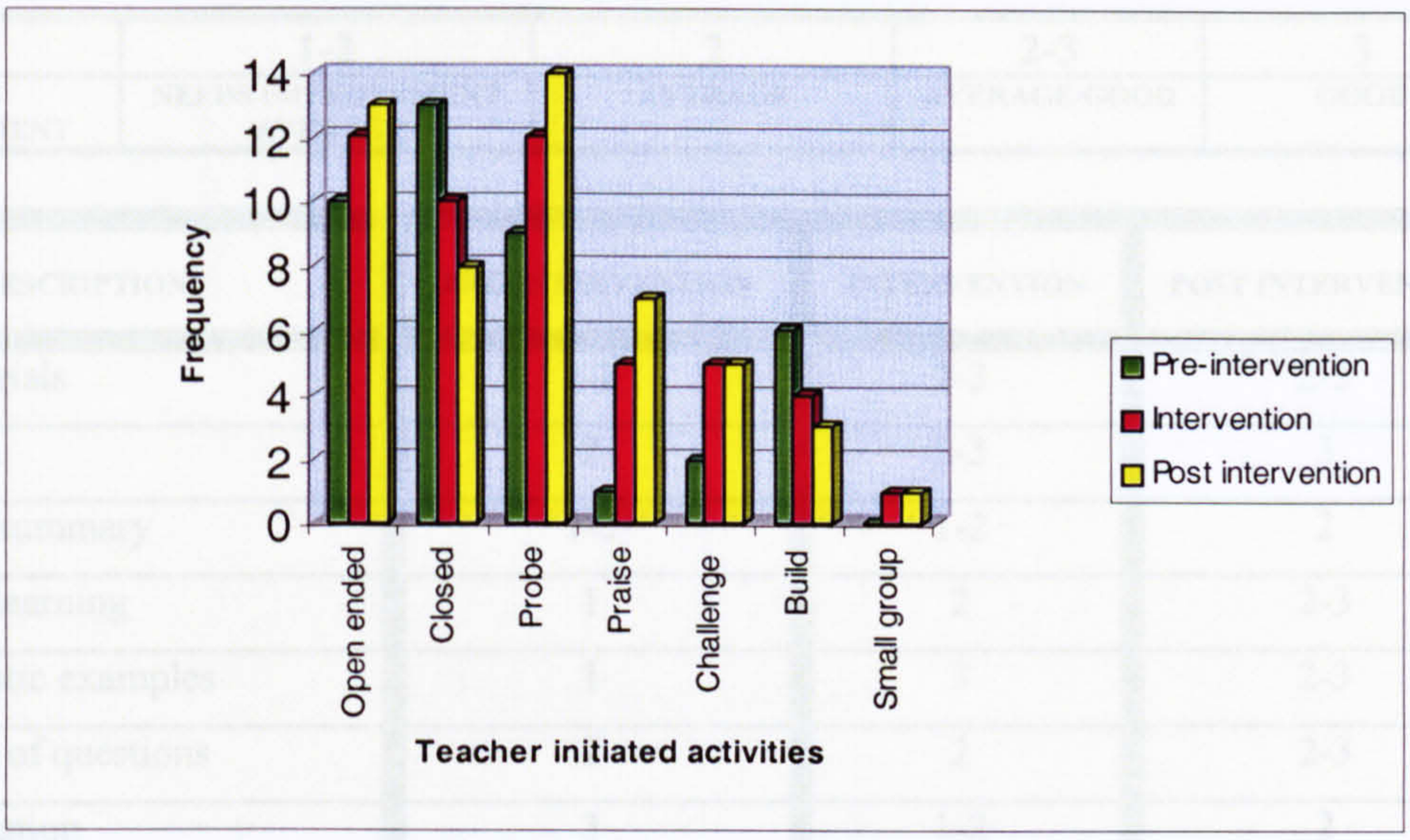

Figure 4.3: Structured observation results (Teacher 4AF, School A)

The descriptive component of lesson observation has revealed a degree of change over time in the teacher's execution of lessons (Table 4.8). At pre-intervention phase the teacher 'needed improvement' in *the use of materials*, *lesson conclusion*, *transfer of learning* and *the use of realistic examples, among others*. However, at the intervention phase, only a few areas needed improvement. During the post intervention phase, the teacher maintained an 'average' to 'good' performance in all aspects of delivery. Like Teacher **3AM,** Teacher **4AF** obtained a 'good rating in *task explanation* during the pre-intervention phase but was only 'average' and in some cases 'needed improvement' at intervention and post intervention phases. As mentioned earlier, this quality might have been due to the fact that the teacher was less familiar with thinking lessons and therefore experienced difficulty in terms of explanation during delivery.

Key:

1	1-2	2	2-3	3
NEEDS IMPROVEMENT	**NEEDS IMPROVEMENT /AVERAGE**	**AVERAGE**	**AVERAGE/GOOD**	**GOOD**

DESCRIPTION	PRE-INTERVENTION	INTERVENTION	POST INTERVENTION
Use of materials	1-2	2-3	2-3
Introduction	2	2-3	3
Conclusion/summary	1-2	1-2	2
Transfer of learning	1	2	2-3
Use of realistic examples	1	3	2-3
Distribution of questions	2	2	2-3
Task explanation	3	1-2	2
Diverse problem-solving strategies	1-2	2	2-3

Table 4.8: Descriptive aspect of lesson observation (Teacher 4AF, School A)

Teacher 5AM

Teacher **5AM** demonstrated a greater degree of change between the pre-intervention and the intervention phase as compared with other teachers (Figure 4.4). The highest degree of change was seen in the category of challenging students' responses. There were also improvements in the degree of *praise to students* as well as in the use of *open ended questions*. It was interesting that there was not much change in the frequency of *closed questions* and the *probing of responses* throughout lesson observation. As seen with previous observations, there were no instances of *small group activity* at the pre-intervention phase.

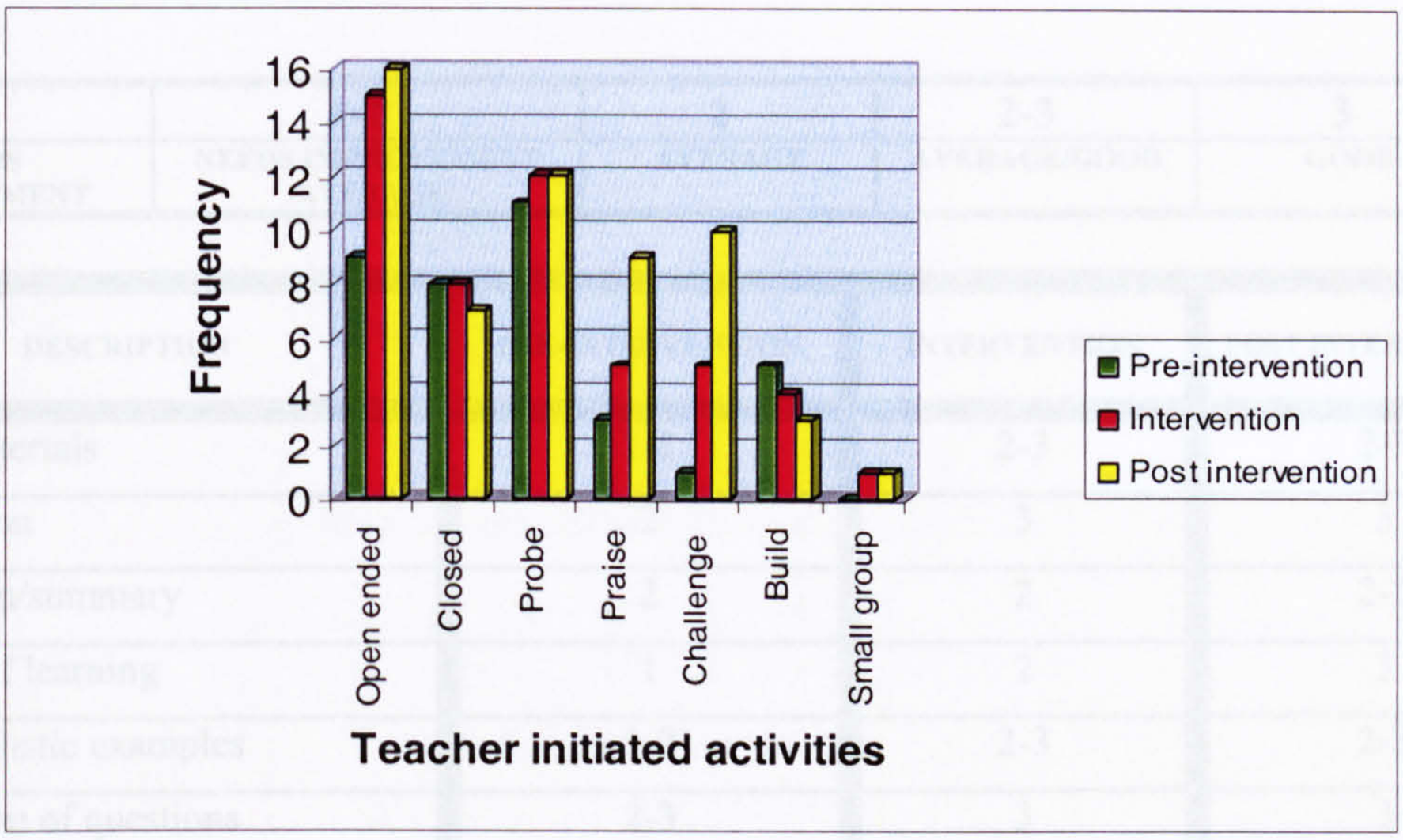

Figure 4.4: Structured observation results (Teacher 5AM, School A)

The descriptive aspect revealed that the teacher had an average performance in most areas of pre-intervention delivery (Table 4.9). However, by the post intervention phase the teacher had 'average' to 'good' performance on all aspects. It was worth noting that the teacher constantly obtained 'good' rating in the areas of *lesson introduction* and *the distribution of questions* during all the lessons observed.

Key:

1	1-2	2	2-3	3
NEEDS IMPROVEMENT	**NEEDS IMPROVEMENT /AVERAGE**	**AVERAGE**	**AVERAGE/GOOD**	**GOOD**

DESCRIPTION	PRE-INTERVENTION	INTERVENTION	POST INTERVENTION
Use of materials	1-2	2-3	2-3
Introduction	2	3	3
Conclusion/summary	2	2	2-3
Transfer of learning	1	2	3
Use of realistic examples	1-2	2-3	2-3
Distribution of questions	2-3	3	3
Task explanation	2-3	1-2	2
Diverse problem-solving strategies	1	2-3	2-3

Table 4.9: Descriptive aspect of lesson observation (Teacher 5AM, School A)

Teacher 6AF

Although Teacher **6AF** demonstrated some change between pre-intervention and intervention phases. Like many other teachers, there was only limited change between intervention and post intervention phases (Fig. 4.5). There appeared to be no change in the frequency of *closed questions*, *challenge* and *small group activity* between intervention and post intervention phases. This teacher demonstrated notable change in *praising students' responses* and in the use of open-ended questions. It was significant that there were no instances of small group activity at pre intervention observations. The use of small group activity during the intervention and post intervention phases might have been due to the fact that thinking lesson plans required students to work together in small groups on some occasions.

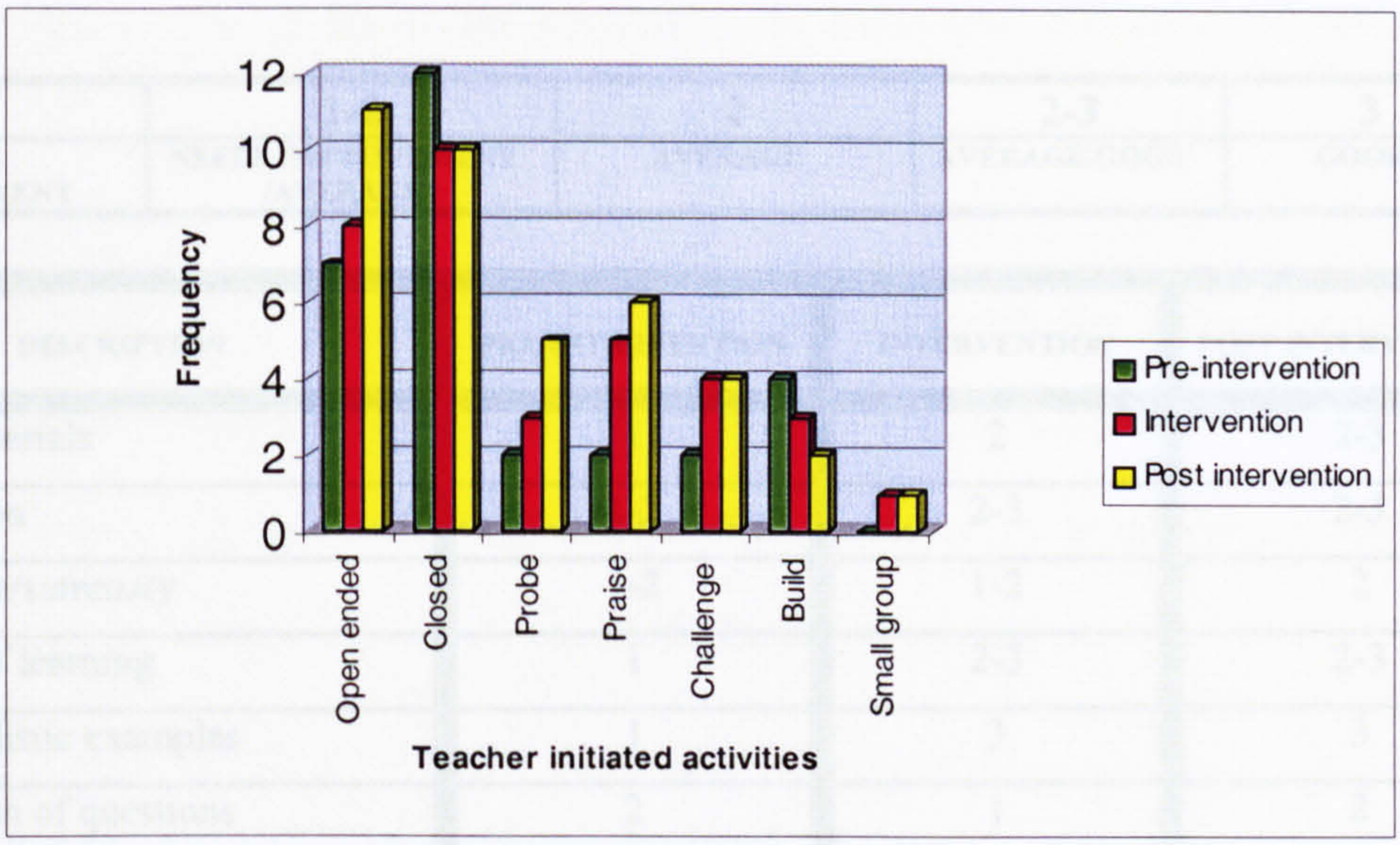

Figure 4.5: Structured observation results (Teacher 6AF, School A)

There was a similar pattern of change in other areas of lesson delivery (Table 4.10). During the pre-intervention phase, the teacher 'needed improvement' in most aspects of delivery. However, by the intervention phase there was obvious improvement. However, there was not much change between intervention and post intervention phases.

Key:

1	1-2	2	2-3	3
NEEDS IMPROVEMENT	**NEEDS IMPROVEMENT /AVERAGE**	**AVERAGE**	**AVERAGE/GOOD**	**GOOD**

DESCRIPTION	PRE-INTERVENTION	INTERVENTION	POST INTERVENTION
Use of materials	1	2	2-3
Introduction	1-2	2-3	2-3
Conclusion/summary	1-2	1-2	2
Transfer of learning	1	2-3	2-3
Use of realistic examples	1	3	3
Distribution of questions	2	1	2
Task explanation	2	1	2
Diverse problem-solving strategies	1-2	2	2-3

Table 4.10: Descriptive aspect of lesson observation (Teacher 6AF, School A)

4.7.1: Summary of lesson observations (School A)

It was of interest that most teachers made greater progress between the pre-intervention and intervention phase as compared to improvements made between the intervention and post intervention phase. The fact that teachers made little progress during the post intervention phase might have been attributed to the reduced level of support provided during this period. The following conclusions could be made from the lessons observed.

- *All teachers demonstrated some level of positive change during lesson delivery from pre-intervention to post intervention phases.*
- *There was generally a greater level of change between pre-intervention and intervention phases as compared to changes between intervention and post intervention phases.*

- ❖ *The results of lesson observations were consistent, for the most part, on both structured and descriptive aspects of lesson delivery.*

One could conclude that the lesson observations have supported the journal entries to some extent in the sense that the teachers of **School A,** have all demonstrated change in practices. However, it was felt that individual teacher's perspectives on such change would be of immense value in order to objectively assess the degree of change.

4.8: Post intervention interviews (School A)

As done with pre-intervention interviews, data from post intervention interviews were divided into the following four categories:

- o *Beliefs on teaching*
- o *Teaching practice*
- o *Professionalism and professional growth*
- o *Teachers' accounts of students' attitudes to their teaching*

- ❖ *Beliefs on teaching*

Teachers were asked whether there were changes in their beliefs on the teaching and learning of Mathematics. Teacher **1AM** replied '*I already held the feeling that practical approaches work but now I am pretty convinced*'. The teacher claimed that he was still '*...convinced that whole class teaching is simpler for the teacher but students don't benefit as much from this strategy'*. According to the teacher '*...if one aims to foster sustained learning, then the use of traditional, whole class teaching should be minimised*'. He felt that the main reason for lack of change in practice was because the Education Systems '*...does not help...*'

The teacher maintained his beliefs pertinent to the use of challenge in his claims that challenge is '*...very important for the development of Mathematical concepts*'. He claimed that although challenge is useful '*...an overemphasis on challenge and thinking skills can be intimidating to students, particularly the weaker ones who can't always reach the target'*. From the above response, one could conclude that although there appeared to have been a slight increase in the teacher's convictions, there was not a dramatic change in beliefs.

On the issue of potential changes in beliefs, Teacher **2AM** indicated that *'...students understand Mathematics better when it is practical and hands-on.'* This represents a change of perspective since during the pre-intervention interview this teacher indicated that practice in the use of formulas to solve problems was the most important element for learning Mathematics. There was also a change of perspective in terms of the teacher's views on whole class teaching and small group activities. Contrary to his views during the pre-intervention interviews, Teacher **2AM** indicated that although whole class teaching '*...is kind of effective sometimes...'* small group activity '*...is more effective because...*'...teachers...'*...might miss out a lot of children during whole class teaching.*' The teacher thought that challenge should be a regular feature in the classroom since it allows students to *'...look at different problems and come up different situations in solving them.* Again, this was different from his response during the pre-intervention interview where he indicated that students hate Mathematics since they considered it to be too challenging. Hence, it could be concluded that this teacher experienced change in beliefs.

Like the other teachers, Teacher **3AM** felt that although whole class teaching was '*...easier for the teacher, it is not the best method since students rarely remember the contents of the lesson*'. The teacher conceded that small group activities appear to work better than he originally thought particularly '*...if the teacher is well organised and knows what he or she is about'*. However, he thought that such activities must be undertaken '*...with a direct purpose in mind'*.

The teacher suggested that one of his major areas of learning from the research was the difference between difficulty and challenge. He admitted that during the delivery of thinking lessons he was '*...always consciously aware of the difference between difficulty and challenge*'. Although this teacher already held a progressive view of Mathematics teaching and learning during the pre-intervention interviews, the preceding confession has shown a slight change in beliefs.

Teacher **4AF,** when asked to relate her opinions on potential changes in beliefs on the teaching and learning of Mathematics, replied,

> '*...now I believe that Maths should be taught differently because when students think things and come up with solutions for themselves you find that it will stay up there...'* [pointing to the head] '*...rather than if you just tell them and they have to remember what you tell them'*.

The teacher thought that grouping students was a better strategy than whole class teaching since '*...it is better to group them according to their abilities and to work with them at that level'*. She admitted that in the past she considered small group activities as '*...something the teacher does when there is no real objective to the lesson or when the teacher forgot to plan for the next day's session'*. She further claimed that it is good to challenge students since this

'*...assists students to formulate their own opinions and to understand things their own way*'. Again, this response was somewhat different from that provided during the pre-intervention interview where the teacher indicated that students appear not to have the level of thinking that is needed for Mathematics learning.

Teacher **5AM,** on the question of change in beliefs, claimed '*...when students are more involved they learn more'*. The teacher felt that teachers should still use interactive approaches even if the education environment is not conducive to the use of such method. According to the teacher, '*...I believe that if the teacher wants, he or she can still use this strategy irrespective of all the other constraints in the teaching environment*'. He believed '*...any student can achieve if given a chance, along with the right classroom atmosphere*'. On the issue of beliefs on whole class teaching the teacher indicated that '*...it is not the best method because students hardly remember the stuff...*', [meaning the contents of the lesson]. He felt that '*...well managed small group activities definitely work'*. However, he expressed concern with the time consuming nature of small group activities. The teacher had a different perception about challenge in his confession '*...I think that students are capable of thinking much more than we give them credit for'*. The teacher's viewpoint does not represent a significant shift in beliefs because a comparison with pre-intervention interviews suggests that he maintained slightly similar views on the teaching and learning of Mathematics.

Teacher **6AF,** on the question of change in beliefs claimed '*...a more hands-on approach is needed for the teaching of Mathematics'*. She believed such approach '*...provides students with the skills that they would need for the outside world'*. When asked to give her opinions on

challenge, the teacher suggested that it is always good to challenge students but with the below average class the teacher '*has to be careful since challenge to them may mean frustration since they have the tendency to give up quickly*'. The latter would indicate a degree of change in beliefs since during pre-intervention interviews the teacher claimed that Mathematics learning should be mainly about giving students practice and providing them with strategies so that they can solve problems.

❖ *Teaching practice*

Teachers were asked to comment on their practical teaching strategies in order to determine potential discrepancies between beliefs and practices. Teacher **1AM** indicated that there was '*...a slight change...*' in practice. However he felt this change would have been greater '*...if the Education System was different...*' He considered some possible constraints as extra large classes and the pressures of completing the syllabus within the school year. The teacher described his normal Mathematics lessons as '*...somewhat similar...*' to past approaches but indicated that '*...there was added use of varied strategies including small group activities*'.

The fact that normal lessons incorporated some degree of group work would constitute change in practice since the teacher rarely used such strategies in the past. The teacher suggested that thinking lessons were '*...certainly more practical than normal lessons...*' an that '*...the work was less frustrating for students with poor writing skills'*. He also admitted to changes in the way he catered for students with varying abilities by '*...assisting them more on a one-to-one basis'*.

Teacher **2AM** claimed that there was not a distinct change in his approach. However, he indicated that during thinking lessons students '*...definitely participated more...*'. According to the teacher students '*...looked at different ways of solving the same problem; something that they hardly did in their normal Maths lessons.*' He believed '*...thinking lessons seems to be a great way to get the message across.*' On the question of catering for students with diverse abilities, the teacher claimed that he would attempt to make examples as '*...simple and down-to-earth as possible*'. This appeared to be different from the strategy of pitching lessons at the average as utilised before the intervention.

Teacher **3AM** claimed that he was '*...more patient and tried a greater variety of approaches*'. He indicated that the thinking lessons were '*...activity oriented...*' and they '*...definitely influenced...*' the way he taught. Like the other teachers, he considered thinking lessons as 'hands-on' and indicated that he *...never thought that students would love hands-on activities at this level*'. The teacher further claimed that he catered for differing abilities by ensuring that '*...the weaker ones were identified and assisted...*' The above response represents a slight degree of change in practice.

Teacher **4AF** indicated that she tried as much as she could to have normal lessons that were activity oriented where students could actually do things and have fun learning Mathematics. She however indicated that was difficult due to constraints such as a lack of formal training, time constraints and lack of resources. The teacher attested to the use of 'graded practice' to cater for diverse abilities in the classroom. According to the teacher,

'I would give all students some to do on the board. The faster ones I would give them a little bit more or those that are a bit harder and in the mean time, I would work with the slower ones during this period'.

This was somewhat different from the teacher's strategy of pitching lessons at the average child as practiced before the intervention programme.

Teacher **5AM** on the issue of change in practice claimed that he tried to make his normal lessons '*...more student oriented...*' even when he did not have the necessary materials. According to the teacher, '*...it wasn't like I did not know how to do that but I decided to give it a try this time irrespective of the constraints of the system'*. The teacher claimed that there was some change in his normal Mathematics lessons since '*...students had a greater proportion of hands-on activities*'. Another aspect of change in practice was the teacher's acknowledgement that he attempted to '*...incorporate some sort of challenge into every lesson...*' and '*...that seemed to have worked well for students*' The teacher suggested during thinking lessons, less might have been achieved in terms of attaining the objectives due to change of strategy. However, he admitted '*...what was achieved was in greater depth and quality*'. According to the teacher, '*...students definitely remembered practical lessons because they were interesting and captivating*'. He attested to catering for students with diverse abilities through '*...greater use of co-operative learning and peer tutoring*'. The above account represented notable change in practice.

Teacher **6AF** believed her normal lessons were similar to those done in the past but she attempted to change her approach to questioning. She claimed that she had a greater degree of consciousness while teaching and attempted to devote more time to individual students.

According to the teacher, '*...giving students individual attention definitely works, particularly for the weaker ones'.*

- *Professionalism and professional growth*

Teachers were asked a series of questions in order to determine the degree of professional growth among the staff. On the issue of reflection on practice, all teachers confessed to a degree of change in their ability to reflect in the sense that they devoted more time to reflection and consciously thought about their practice. Teacher **1AM** felt that reflection was necessary since teachers have to account for the kids entrusted in their care. He argued that through reflection, '*...the teacher sees things from a different angle and from a more objective viewpoint'*. He further admitted that in looking at ourselves we '*...at least see whether we are doing a good job and whether we deserve the pay that we get'*.

Teacher **2AM** indicated '*...if after you have taught a lesson you never go back to look at it, you will not know where your weak points are.*' The teacher admitted that in the past his aim was '*...just to complete a topic...and move to another...*'in order to complete the syllabus. Teacher **3AM** shared similar sentiments with Teacher **2AM** in his claims that '*...teachers should reflect on their practice since this is the only way to ensure that strengths and weaknesses are identified so that one could set targets for improvement*'. He also admitted that in the past he was unaware of '*what reflection was all about'*.

Teacher **4AF** admitted reflection assisted him in thinking about the lesson so that he could try to improve in the following lesson. Like Teacher **3AM,** he indicated that he did not know what

it was a year ago. Teacher **5AM**, on the other hand, indicated he knew that reflection was essential but he '*...could not make the connection where it helped to improve practice'* since he thought that it was more '*...for other professionals and not necessarily a thing for teachers to do*'. Teacher **6AF** suggested that reflection helps the teacher to constantly '*...seek a better approach...*' to teaching. The teacher conceded that in the past she would informally discuss with a colleague issues relating to slow learners but for the most part, she never reflected on practice.

On the issue of collaboration, all teachers suggested that there were changes in the nature of collaboration among staff since they were able to meet formally and discuss teaching and learning issues. They were of the view that staff meetings were more frequent and more focussed. In light of the above, one could conclude that there was a degree of professional growth for all the teachers during the intervention period.

❖ *Teachers' accounts of students' attitudes to their teaching*

Teachers were asked to give their perceptions on students' patterns of behaviour during thinking lessons. Most teachers indicated that there was a greater degree of interaction during thinking lessons. Teacher **1AM** noted that '*...students' responses appeared less focussed during thinking lessons than normal lessons*' since they tended to '*...stray a bit in their answers...*' However, he suggested that after probing, the teacher tends to '*...get where they are coming from'*. He added thinking lessons appeared '*more philosophical and students enjoyed arguing and defending their viewpoints*'.

Teacher **2AM** felt that there was not a noticeable difference in the pattern of student interaction from the outset because '*...their mental barrier towards Mathematics at times influenced participation'*. The teacher claimed that students did not initially challenge each other '*...since there was a culture of accepting whatever exists.'*

Teacher **3AM** suggested that there was not a noticeable pattern of longer responses but students showed '*...a level of thinking...'* and '*...they were more willing to reason out and defend their ideas'*. The teacher believed that at some point during implementation '*...students' responses were more focussed and that showed they had given some thought to what they were about to say'*. He acknowledged students' dislike for traditional teaching methods in his claims that '*...in the past students always tried to get the smallest excuse to avoid doing Mathematics'*.

Teacher **4AF** confessed that with thinking lessons, '*...everybody had a chance to think about what was going on.* Like other teachers, she felt that students asked few questions besides those seeking clarification. Teacher **5AM** claimed students talked more and their interaction was '*...more focussed on the activity...'* at hand. The teacher felt that the higher level of contribution by students might have been due to '*...increase in praise to the students'*. A point of interest was the teacher's claims that '*...students provided strange responses to questions...but when they were allowed to explain themselves one could see the reasoning behind their answers...*' He argued when teachers '*...say that kids provide wrong answers, it was just a matter of the teacher not understanding the reasoning behind the kids' responses'*.

The preceding confession would mean that, unlike the perception of some teachers during the research, the students are able to think.

Teacher **6AF** suggested that at the beginning of the intervention, students who were brighter participated more because of their self-confidence, whereas those at the lower ability scale were not as keen at first. She indicated that she had to ask students '*...deeper questions to get longer responses out of them'*. This might mean that the nature of students' responses would depend on the teacher's questioning style as well as the type of questions asked. The above responses point to a degree of change in students' patterns of behaviour. However, this change was not immediate.

4.8.1: Summarising post-intervention interview responses *(School A)*

The following represents a summary of post-intervention interview responses from teachers of **School A:**

MAJOR ISSUES	SUMMARY OF RESPONSES
Beliefs	Students have better understanding and memory when Mathematics teaching is practical. Small group activity works better when the teacher is well organised. Students are better able to retain information when they come up with their own solutions. Challenge in the classroom assists students in formulating their own opinions. Whole class teaching is simpler for the teacher but students do not benefit as much from this strategy Students are capable of thinking more than we give them credit.
Practice	Students participated more during practical lessons There was increased use of varied strategies including small group activities. Thinking lessons were more practical than normal lessons. There was a greater degree of individual assistance during lessons. Challenge was incorporated into every lesson Students were allowed a greater degree of decision-making and problem solving power. Thinking lessons were time consuming.
Professionalism and professional growth	After teaching a lesson the teacher needs to look back on the strengths and weaknesses Reflection helps the teacher identify weaknesses and build on strengths. Teachers need to devote more time to reflection and consciously thinking of practice. There was greater focus during staff discussion.
Teachers' account of students' attitudes to their teaching.	Students displayed a higher level of participation during thinking lessons. When students were asked deeper questions they provided more elaborate responses. Students were more willing to reason out and defend their ideas during thinking lessons. On occasions students' responses were less focussed. Increase in praise meant an increase in volunteered responses from weaker students.

Table 4.11: Summary of post-intervention interview responses from School A

4.9: Mapping changes in teachers' beliefs and practices *(School A)*

An attempt was made to map teachers on a matrix based on beliefs and practices before the intervention (Fig. 4.6). Teachers were considered on either end of a continuum with *behaviourist* conceptions on one end and *social constructivists* on the other. *Behaviourist* conceptions were considered those relating to *traditional* classroom practices such as rote learning, direct instruction and other methods where the teacher has a high degree of control over students' learning. *Social constructivists'* conceptions, on the other hand, were considered those relating to teaching approaches where students take greater control of their learning. This was characterised by a high level of student interaction, a fair degree of student autonomy and decision-making potential and the use of a social context for learning.

65
84
221
265

70
86
221
265

From *pre-intervention* data it was concluded that Teachers **2AM, 4AF** and **6AF** all held *behaviourists* beliefs and practices on the teaching and learning of Mathematics (Fig. 4.6). On the other hand, Teachers **1AM, 3AM** and **5AM,** held *social constructivists* beliefs but their practices were relating to *behaviourists* conceptions.

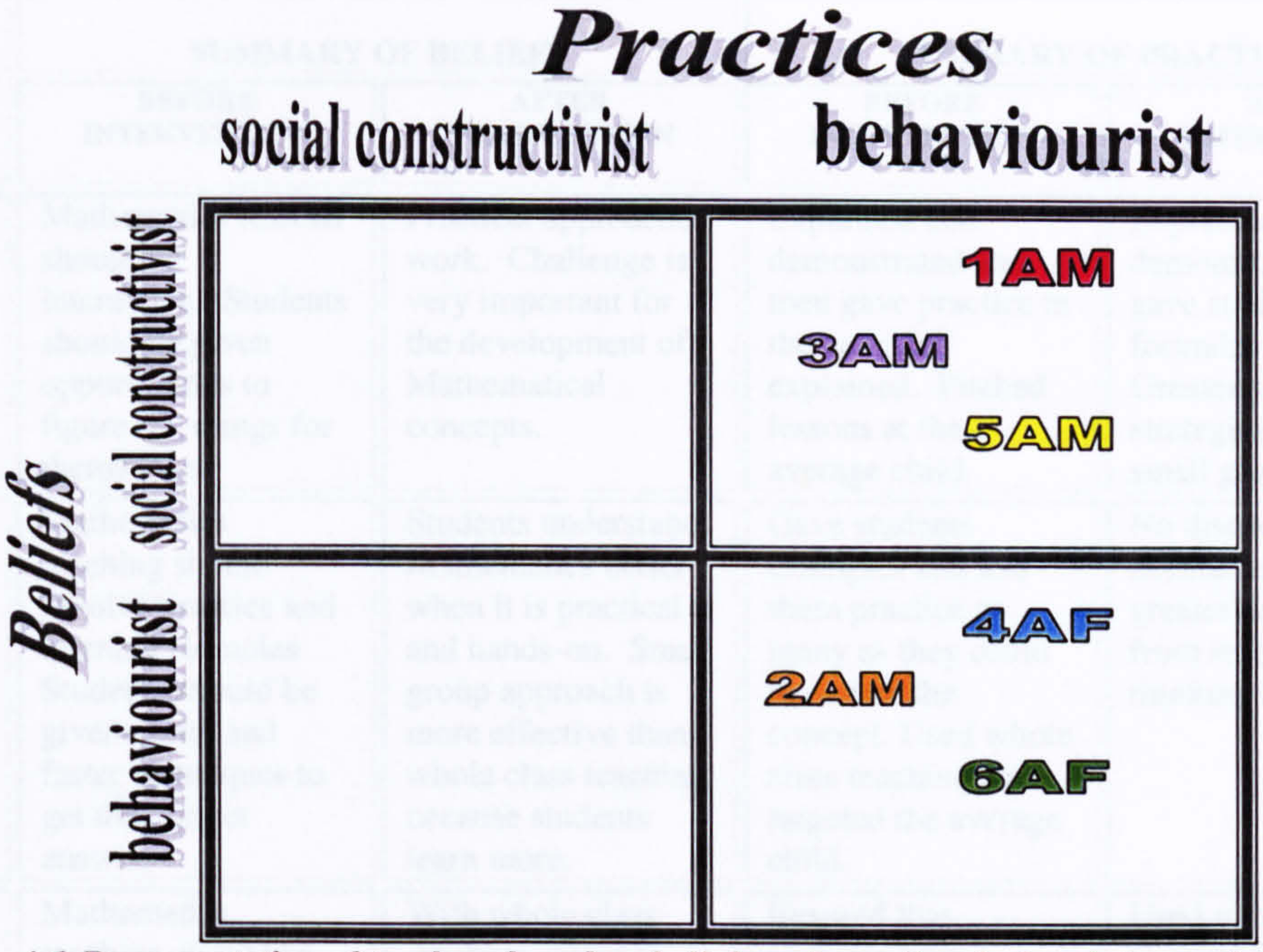

Fig. 4.6: Representation of teachers based on beliefs and practices before intervention (School A)

Key:

Social constructivists: *Contemporary beliefs and practices*

Behaviourist: *Traditional beliefs and practices*

The data collected from pre and post intervention interviews and lesson observation were consulted in order to determine the approximate degree of change experienced by each teacher. From a summary of teachers' interview responses (Table 4.12) and lesson observation, one could conclude that, however minimal, there was a degree of change in beliefs and practices of *all* teachers.

TEACHER CODE AND STATUS	SUMMARY OF BELIEFS		SUMMARY OF PRACTICES	
	BEFORE INTERVENTION	AFTER INTERVENTION	BEFORE INTERVENTION	AFTER INTERVENTION
1AM Trained	Mathematics lessons should be interactive. Students should be given opportunities to figure out things for themselves.	Practical approaches work. Challenge is very important for the development of Mathematical concepts.	Explained and demonstrated and then gave practice in the concepts explained. Pitched lessons at the average child.	Explained and demonstrated and gave students formulas to practice. Greater variety of strategies including small group activity.
2AM Untrained	Mathematics teaching should involve practice and learning formulas. Students should be given easier and faster techniques to get the correct answers.	Students understand Mathematics better when it is practical and hands-on. Small group approach is more effective than whole class teaching because students learn more.	Gave students examples and had them practice as many as they could to master the concept. Used whole class teaching and targeted the average child.	No distinct change in normal lessons but greater participation from students during thinking lessons.
3AM Untrained	Mathematics teaching should be about activities. Lessons should be fun and not stressful.	With whole class teaching students rarely remember contents. Small group activity works well if the teacher is well organised.	Ensured that students were always engaged. Used whole class teaching and pitched lessons at the average child.	Used varied strategies. Catered for students with different abilities by ensuring that weaker ones were identified and assisted
4AF Untrained	Students should be given formulas and shown the fastest ways to get problems correct.	Students learn best when they think things and come up with their own solutions. Students should be allowed to formulate their own opinions.	Demonstrated strategies and allowed students to practice. Used whole class teaching most often.	Mainly used whole class teaching but tried to have lessons that were activity oriented. Used 'graded practice' to cater for diverse abilities.
5AM Trained	Mathematics teaching should be creative and the teacher should make the subject matter interesting and relevant.	When students are involved they learn more. Well-managed small group activities definitely work.	Attempted to make lessons interactive and stimulating. Used whole class teaching quite frequently.	Lessons were student-oriented. Students had a greater proportion of hands-on activities and there was greater use of challenge.
6AF Untrained	Maths should involve a lot of practice. Students should have strategies to remember formulas that they can use in exams.	A 'hands-on' approach is needed for the teaching of Mathematics. Students need to be challenged. Lessons should cater for individual needs.	Modelled the solutions to problems and then provided students opportunities to practice similar problems. Used whole class teaching most often	Used mainly whole class teaching but attempted to change questioning approach. Attempted to cater for individual learning needs.

Table 4.12: A summary of pre and post intervention beliefs and practices (School A)

An attempt was made to represent teacher change taking into account the factors influencing teachers' beliefs and practices as mentioned in earlier sections of this study. In order to ensure that the representation of teachers was objective, the researcher attempted to establish inter-rater reliability based on a series of subjective representations of teachers. This was done by allowing five in-service training providers to study the pre and post intervention data. They were then asked to map teachers on a chart based on their perceptions of the degree of change experienced by each teacher. Due to space limitations, only three of the representations were provided in this document (Figs. 4.7 and 4.8 and 4.9).

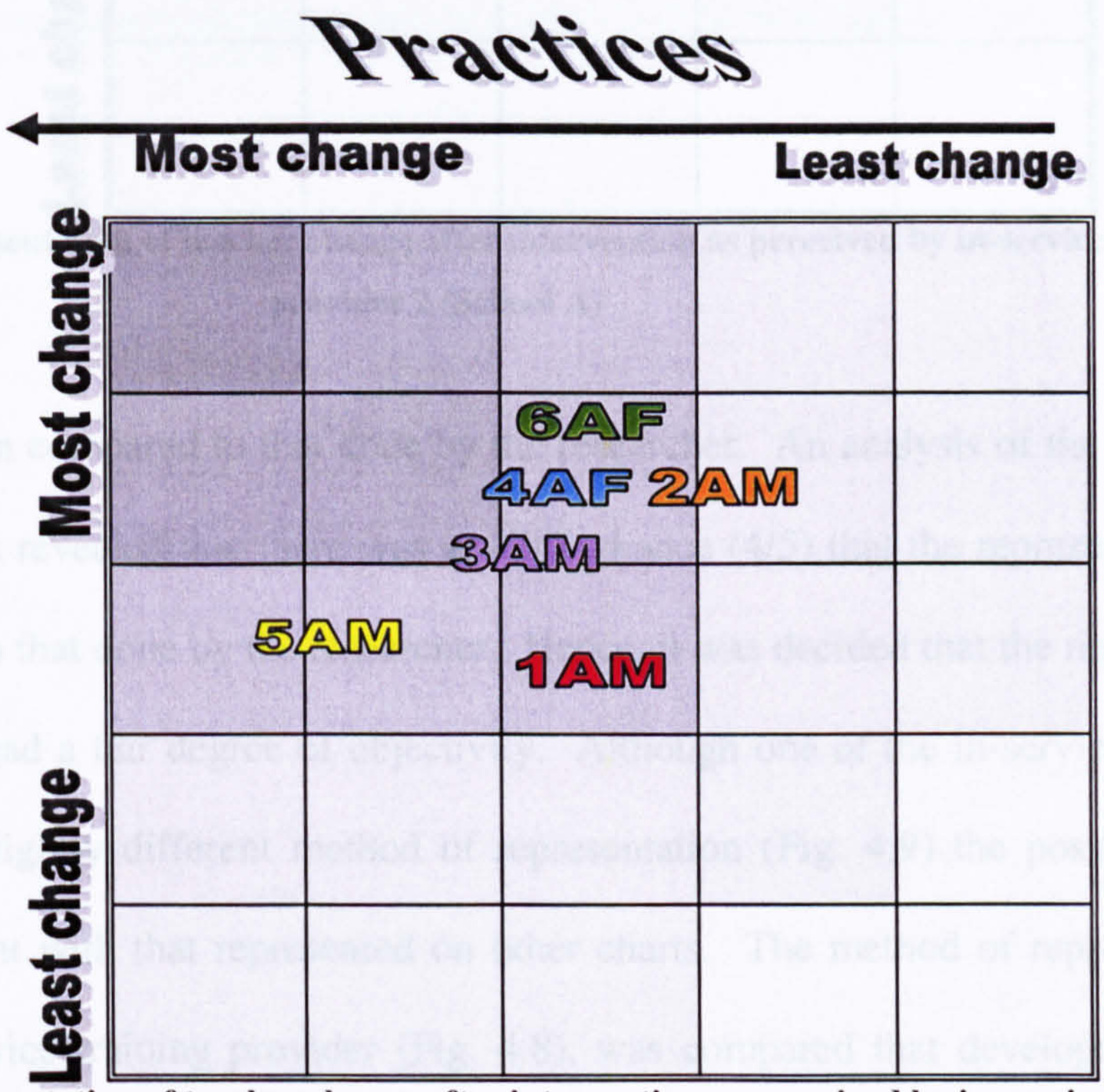

Fig. 4.7: Representation of teacher change after intervention as perceived by in-service training provider 1 (School A)

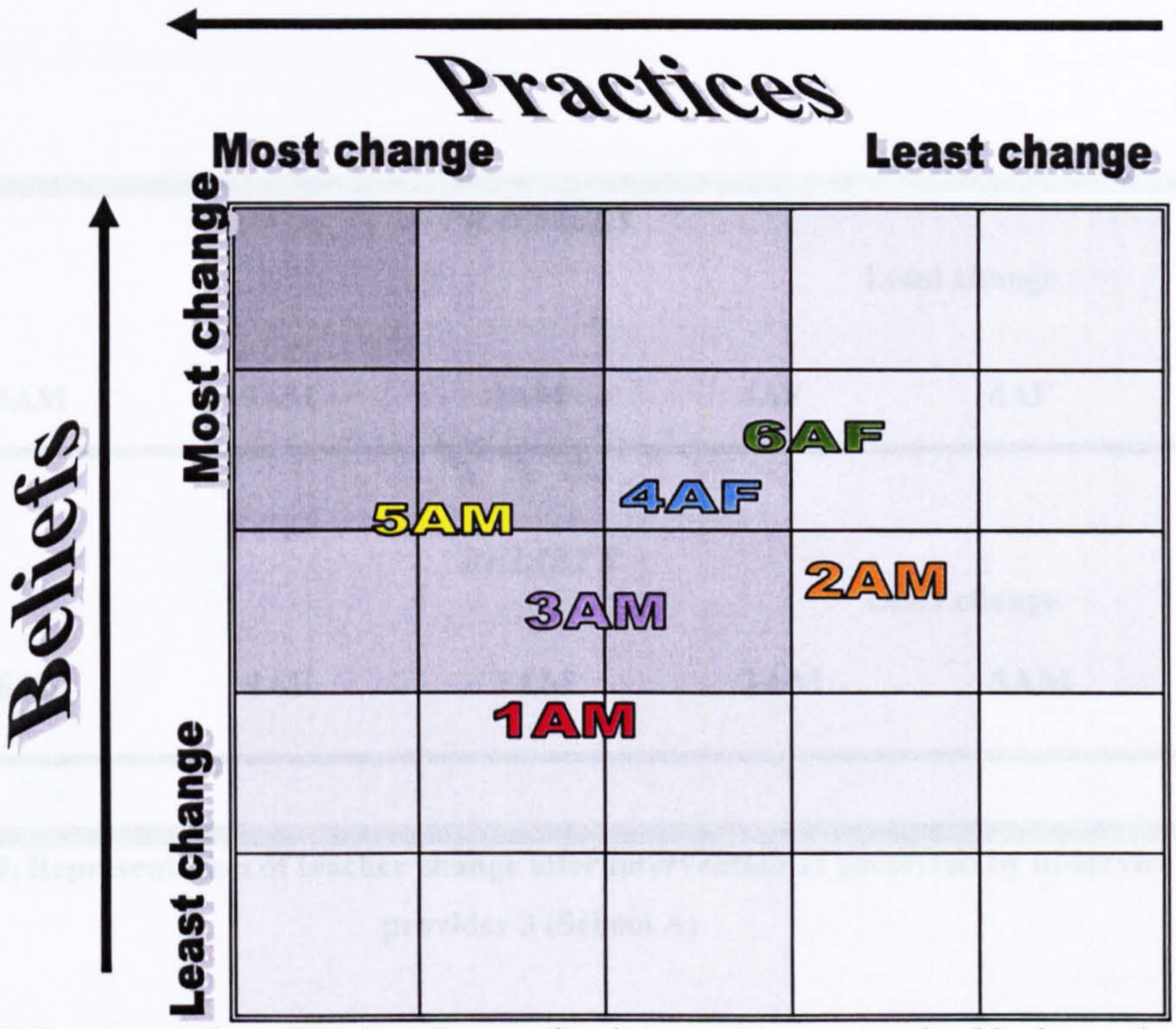

Fig. 4.8: Representation of teacher change after intervention as perceived by in-service training provider 2 (School A)

This mapping was then compared to that done by the researcher. An analysis of the results of the inter-rater exercise revealed that there was an 80% chance (4/5) that the representation of teachers was similar to that done by the researcher. Hence, it was decided that the researcher's mapping of teachers had a fair degree of objectivity. Although one of the in-service training providers utilised a slightly different method of representation (Fig. 4.9) the positioning of teachers was consistent with that represented on other charts. The method of representation utilised by the in-service training provider (Fig. 4.8), was compared that developed for the study. The representation appeared to use a norm reference system to compare teachers on a continuum and was considered inappropriate because the primary objective was to use a

system that would compare teachers against the criteria of beliefs and practices but not against each other.

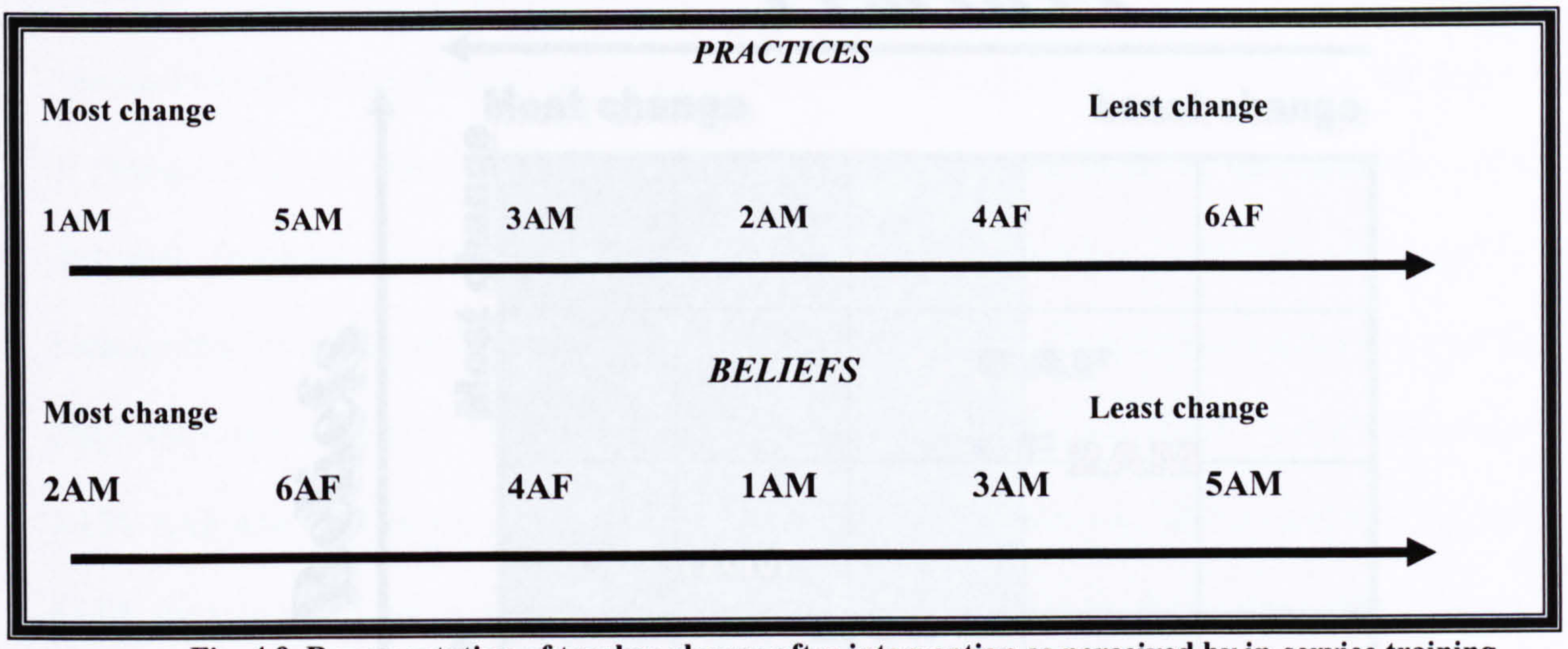

Fig. 4.9: Representation of teacher change after intervention as perceived by in-service training provider 3 (School A)

The following representation serves only as a guide to determine the ***approximate*** degree of change in the beliefs and practices of teachers of **School A.**

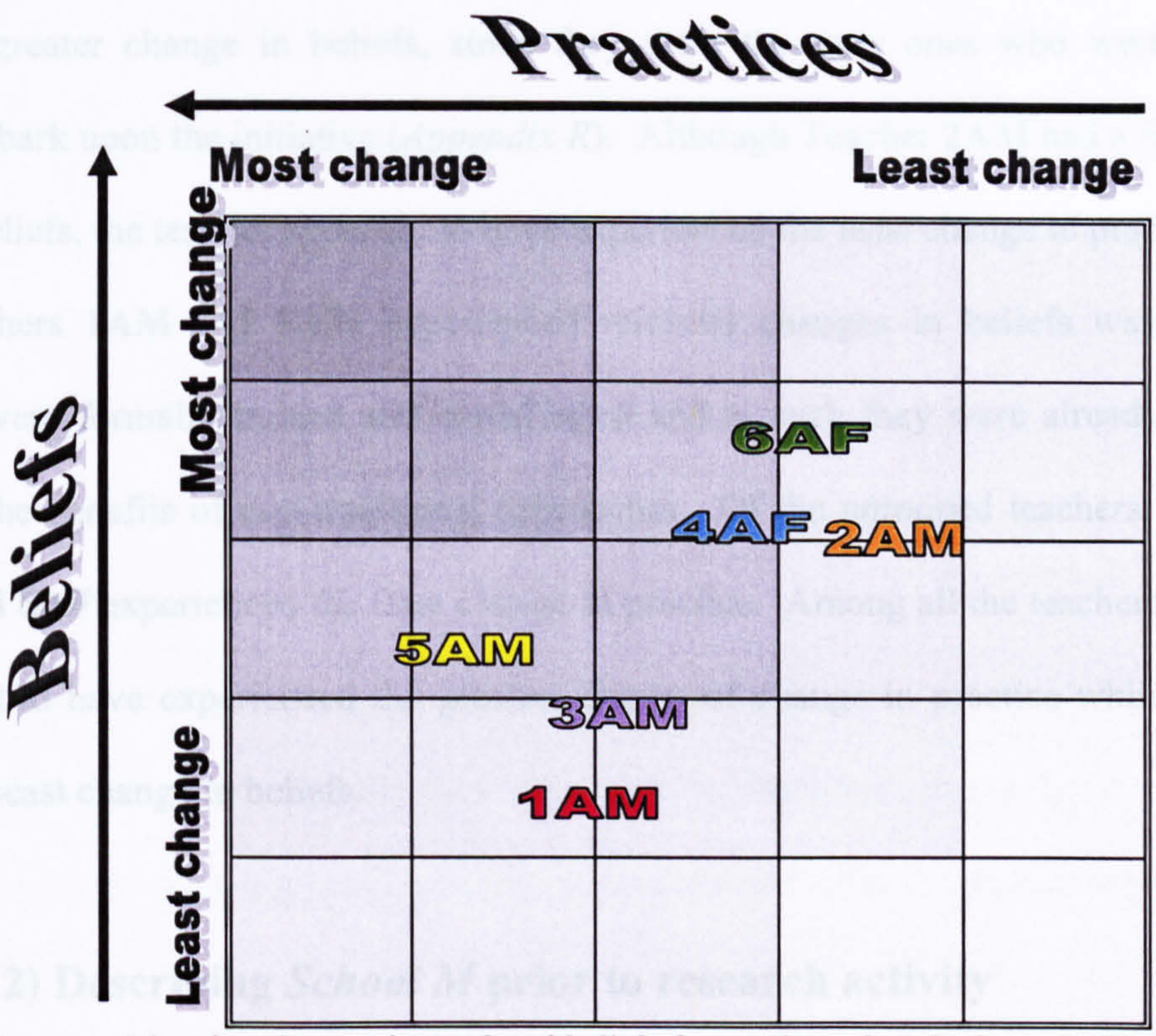

Fig. 4.10: Mapping changes in teachers' beliefs & practices after the intervention (School A)

One could conclude that there were varying degrees of change in the beliefs and practices of these teachers. This variation could be attributed to a number of factors affecting each individual. Some of these factors included teacher experience and training, levels of motivation and teachers' position on the organisational framework of the school, among many others. It must be noted that the position of teachers on the grid should *only* serve to give a rough indication of the degree of change as viewed from teachers' comments and actions and therefore would probably make little sense if viewed in isolation of teachers' perceptions and practices as revealed by the research.

The greatest degree of change in beliefs was seen in Teachers **2AM, 4AF** and **6AF** who were all untrained, inexperienced teachers (Figure 4.10). It was interesting that these teachers demonstrated greater change in beliefs, since they were the very ones who were initially reluctant to embark upon the initiative (*Appendix R*). Although Teacher **2AM** had a fair degree of change in beliefs, the teacher appeared to have experienced the least change in practice. The fact that Teachers **1AM** and **5AM** experienced minimal changes in beliefs was possibly because they were formally trained and experienced and as such they were already partially convinced of the benefits of non-traditional approaches. Of the untrained teachers, Teachers **2AM, 4AF** and **6AF** experienced the least change in practice. Among all the teachers, Teacher **5AM** appeared to have experienced the greatest degree of change in practice while Teacher **1AM** held the least change in beliefs.

4.10: (Case 2) Describing *School M* prior to research activity

As done with **School A**, each of the teachers this school was given a code comprising a number in chronological order (**7-9**), the school code (**M**) and the teacher's sex (**M** or **F**). Hence, the first female teacher of this school was coded **7MF**. The following is a description of the school prior to the practical research activity.

- *School setting*

This was a small, state co-educational school in a rural community approximately 25 miles away from the capital city. The school was founded in 1980 and was relatively spacious. The pupil to teacher ratio was one teacher to sixteen students (1:16) but the approximate class size

was much higher. Located within a farming community, the school was fully supported by the community.

- *Principal and staff*

The principal had a different leadership style as compared with **School A.** Although teachers were supportive of the principal, there seemed an underlying sense of contrived collegiality. Hence, teachers appeared coerced into many school activities.

- *Students*

Most students resided in the community within which the school was located. Like **School A,** students were of the same educational, socio-economic and cultural settings but they were of varying abilities. In the past, teachers shared the perception that only the weaker students were sent to this school.

- *Classroom setting*

Students were placed in rows with the teacher at the front of the class. There were very few teacher displays and no student displays in classrooms. Students were remarkably quiet during lessons, particularly when the principal was in the vicinity.

- *School performance*

In past years, student performance was minimal at this school and as such many parents attempted to register their children with better performing schools. The school was also low on discipline during this period. The current principal, however, appeared to have addressed some

of the discipline and performance issues, consequently generating a change of view from the community.

4.10.1: Teachers' profiles (School M)

The Mathematics Department of **School M** was made up of only three (3) teachers who were all untrained. The Head of department was not formally trained but was attending an associate degree programme. All teachers within the Department had limited teaching experience. Table 4.13 depicts information pertinent to the teachers of **School M.**

TEACHER CODE	POSITION	EXPERIENCE	TRAINING
7MF	Classroom teacher	2 years	None
8MF	Classroom teacher	2 years	None
9MM	Head of Department	5 years	Attending an Associate Degree Programme

Table 4.13: Teachers' Profile (School M)

4.11: Pre-intervention interviews (School M)

Interview responses were divided into four sub-categories based on teacher perceptions and practices. The following represents an analysis of each sub-category.

- ❖ *Beliefs on Teaching*

Teachers were asked to relate their perceptions on the teaching and learning of Mathematics. All teachers emphasised the need for practice in the Mathematics classroom. Teacher **7MF** claimed '*...students should remember basic formulas because that's the only way that they will be able to solve problems'*. The teacher further indicated '*...students must think fast because that's important in Mathematics learning.*'

The teachers were then asked their perceptions on the importance of challenge in the classroom and all teachers appeared to equate challenge with difficulty. Teacher **7MF** suggested that '*...the work is hard enough...*' since '*...students always complain that Mathematics is hard...*' She believed challenging lessons are good since '*...they show that different answers might be still correct based on the explanation given*'. However, she conceded that it was difficult to have such lessons since '*...there is usually a set procedure that students have to follow during examinations and giving them one thing during the term and another during examinations is not very fair*'.

Teacher **8MF** claimed that '*...Mathematics should be hands-on...*'. She suggested that '*...the classroom should be a learning environment and students should enjoy doing the subject.*' This represented a progressive view of teaching that was different from that of Teacher **7MF.** The teacher further claimed that such belief could not be materialised since she has '*...limited materials and time to make the classroom stimulating*'. She admitted that it is difficult to have a stimulating classroom since there are no classrooms that remains specially designed for the teaching of Mathematics. She was of the view that although it is good to challenge students, '*...the teacher can't ask students to provide alternative solutions because they won't want to*'.

Teacher **9MM** was of the view that the teaching of Mathematics '*...should be about activities and doing things*'. Like Teacher **7MF,** the teacher stressed the importance of speed in his belief that '*...students should be told that they must have a certain pace...*' since Mathematics learning '*...is not only about getting the answers right but how fast you can get it*'. He claimed

that '*...students should be given time to practice...both in the classroom and at home.*' The teacher further suggested that '*...kids are turned off once they hear of the word challenge, since they like things in the simplest way'.*

- *Teaching Practice*

In an effort to determine whether teachers' beliefs on teaching were consistent with their classroom practices, the teachers were asked to comment on their practical classroom approaches. Teacher **7MF** indicated that her normal lessons '*...were mainly related to modelling and demonstrations*'. She claimed to '*...show students how to do things and then give them practice based on the formulas or methods that they have learnt'.* The teacher conceded using small group activity on occasions but claimed that she '*...had to keep up with the syllabus and small group activity takes time'.*

On the issue of teaching practice, Teacher **8MF** indicated that during normal lessons she tried to get students involved by using '*...problems and activities that relate to the subject...'* She claimed to '*...help them discover certain things...'* but often '*...used the text to give exercises...for practice...to reinforce a concept or for evaluation of a lesson'.* Like Teacher **8MF,** Teacher **9MM** admitted to the use of '*...text quite a bit...*' as an instructional strategy. He was of the opinion that this was not the ideal method but admitted that he was not able to compare methods since he had not experimented with many methods in the past.

Teachers were then asked to comment on their methods of catering for students with diverse abilities in their normal classrooms and each appeared to provide a different account of their

actions. Teacher **7MF** claimed that she '*...tried to ensure that every child was able to work at his or her own level*'. The teacher suggested that small group activity was problematic '*...particularly early in the school year...*' since students were not familiar with their classmates. She indicated that she felt most comfortable with whole class teaching since '*...from a teacher's perspective, you feel that you are in control of your class and you can control the pace and focus of instruction...*' She further admitted that whole class teaching '*...helps the teacher gain grounds in terms of catching up with the syllabus...*'

Teacher **8MF** indicated that she normally gave the problem to the class '*...and moved around to see those who did not understand....* She would then give these students '*...individual assistance while the others are working'*. The teacher felt that small group activity was not a good idea for the younger students since '*...the teacher has to give constant supervision...*'. She added that '*whole class teaching does not work all the time but it is best in terms of efficiency'*. She admitted that planning is facilitated when using the whole class approach '*...since the teacher knows what he or she is going to teach and exactly how long it will take...'*. She believed that in so doing, '*...the teacher can move quickly to the next topic*'.

Teacher **9MM** catered for diverse abilities by '*...dividing the chalkboard into two sections...*' The teacher claimed that he would '*...divide the class into two groups...*' based on those who could and could not understand the concept. He would then give those who did not understand some simpler problems along with additional support. The teacher shared the beliefs of Teacher **8MF** in his suggestion that small group activity rarely works since the students '*...pretend to be working when they are in small groups...*' but they often do very little. He

argued that students '*...waste time talking more about things not related to classroom work than about the contents of the lesson'*. The teacher indicated that with whole class teaching, '*...at least you feel like you are getting somewhere with finishing the term's work*'.

From the above responses, one could conclude that the teachers were generally opposed to the use of small group activity since they felt that it was not an effective approach within their teaching context. Hence, there was a preference for the whole class teaching approach which was mainly due to its ability to make their job easier but not necessarily for its contribution to students' learning.

❖ *Professionalism and professional growth*

In an effort to assess teachers' professional growth, they were asked whether their teaching improved with practice. Teacher **7MF** indicated that her knowledge of the subject was getting better but not necessarily her teaching methods. She believed she could only improve on teaching methods with formal training. Teacher **8MF** claimed '*...a slight improvement in knowing what you do with certain topics...'* According to the teacher '*...you experiment with certain topics, especially if students did not get it in the past*'.

On this issue, Teacher **9MM** indicated that he did not believe his teaching improved with practice. The teacher admitted that he '*...never liked teaching Mathematics...'* He claimed that on several occasions he expressed his lack of interest in teaching the subject and according to the teacher '*...I ended up teaching Maths last year but please don't ask me how...'* The teacher conceded, *'...too many times, too many students out of the class don't understand what I say so that area of teaching is not good for me at all, at all, at all...'* One could argue that the

preceding viewpoint provides some information on the teacher's level of motivation since it appears that he does not want to be a Mathematics teacher at any cost.

Reflection on practice

The teachers were then asked to relate instances where they reflected on the successes and limitations of past lessons. Teacher **7MF** admitted that she rarely reflected. She indicated, if a lesson was '*...extremely bad...*' in terms of delivery, then she would try to figure out where she went wrong and try not to make that mistake in the future. However, she was of the view that time does not permit her to consider the limitations of all lessons. Like Teacher **7MF**, Teacher **8MF** claimed that she thought of how well she taught '*...when someone begins talking about his or her teaching since that makes you think of yourself and how good a job you are doing'.*

Teacher **9MM** admitted that he considered the successes and limitations of his teaching on a constant basis, although not formally. He acknowledged that '*...with Mathematics teaching it is more limitations...*' According to the teacher, '*...I don't do it with my all and ...the enthusiasm is just not there...*' The preceding response also relates to issues of teacher motivation since it was evident that the teacher disliked his role as a Mathematics teacher. On the question of collaboration, the teacher claimed that the staff talked '*...about things that occur during the normal days work'.* They claimed that the staff share information about students and since the staff is very small, they share teaching experiences informally.

❖ *Teachers accounts of students' attitudes to their teaching*

Teachers were asked to relate their perceptions on students' responses to their teaching. They were firstly asked to characterised students' behaviour in terms of their level of interaction.

Teacher **7MF** felt that '*...students talked too much at times and about the wrong things...*' She added that students' ability to think was dependent on their interest in the lesson.

When asked her perceptions on students level of interaction, Teacher **8MF** claimed students talked too much in the classroom. She indicated that '*...the teacher has to keep them quiet all the time...*' She added that '*...they would not necessarily talk when you ask them to, but they do that secretly with their friends...*' The teacher was of the view that students' level of thought would vary on different days.

Teacher **9MM** was in agreement with Teachers **7MF** and **8MF,** in his suggestion that there was greater interaction when students are discussing issues other than the lesson contents. The teacher was asked to comment on students' ability to think about lesson contents and he was of the opinion that '*...students lacked the ability to think...since on many occasions, the response that they would give...would not relate in the least sense to the question asked'.* The fact that teacher felt that students talked too much in the classroom would indicate that students already possess the social competencies to stimulate classroom discussions.

On the question of the length and quality of students' responses all teachers indicated that the length and quality of responses varied depending on individual students as well as the teacher's ability to generate interest among students. They claimed that students rarely challenge others since they '*...accept everything as being correct*'. They also indicated that students rarely ask questions and whenever they did, most of the questions asked were addressed to the teacher.

4.11.1: Summarising pre-intervention interviews (School M)

The following is a summary of pre-intervention interview responses

MAJOR ISSUES	SUMMARY OF RESPONSES
Beliefs	Mathematics teaching should be hands-on and practical. Students should remember basic facts and formulas. Students must think fast because speed is important in Mathematics learning. The classroom should be a learning environment and students should enjoy Mathematics Students should be given time to practice both in the classroom and at home. Students always complain that Mathematics is hard. Many students are not adequately motivated to attempt a challenging question.
Practice	Lessons were mainly related to modelling and demonstrations. Students were shown how to do things and then given practice. Students were helped in discovering certain concepts. Text exercises were used for practice and for lesson evaluation. There was an effort to ensure that every child worked at his or her own level. Some students were given individual assistance while others worked on assigned tasks. There was tension between students during group activities. Whole class teaching helps teachers catch up with the syllabus.
Professionalism and professional growth	Reflection on practice was limited. Staff discussion was centred on students who perform well or poorly during examinations. Ideas were shared on how to teach certain topics and materials that might be needed to teach such topics.
Teachers' accounts of students' attitudes to their teaching	Students talked too much and at times about the wrong things. The teacher has to keep students quiet all the time. The length and quality of students' responses to questions were dependent on individual students and the teacher's ability to generate interest among students. Students lacked the ability to think since on many occasions the response provided would not relate to the question asked. Students rarely challenged others.

Table 4.14: Summary of pre-intervention interview responses (School M)

4.12: Teachers' journals (School M)

The data collected from journals were analysed using coding categories that were derived from the data itself. There were a number of emerging themes from teachers' journals. These were divided into three sub-categories namely, those relating to *teacher development*, those relating to *students' responses* and those relating to the *contents of thinking lessons*. The sub-category of *teacher development* focussed on aspects of professional competence, while the sub-category of *students' responses* concentrated on potential changes to students' behaviour and attitudes to learning. Finally, the sub-category representing *the contents of thinking lessons* focussed on issues relating to teachers' insight on the delivery of thinking lessons. Table 4.15 represents emerging themes as reflected in teachers' journals.

ISSUES REPRESENTING TEACHER DEVELOPMENT	ISSUES REPRESENTING STUDENTS' RESPONSES	ISSUES REPRESENTING LESSON CONTENTS
Lesson delivery was challenging	*Students were reluctant to work with members of their group*	*Students had difficulty understanding instructions on some activity sheets*
There was a degree of consciousness about making mistakes and a sense of unease during lesson delivery	*Greater use of praise encouraged more participation from students.*	*Some students got frustrated with more challenging activity sheets*
Discussion with colleagues assisted in facilitating lessons delivery	*All students were able to contribute regardless of ability*	*Student interest was maintained due to practicality of thinking lessons*
The lessons increased teachers' awareness of the importance of practical lessons.	*During group sessions, there was distraction from nearby groups.*	*Lesson delivery was time consuming.*
There was a feeling of teacher satisfaction when every child gained something from the lesson	**There was potential for loss of focus due to unexpected responses from students.*	*It was difficult to assess individual performance because of a high degree of group activity during thinking lessons.*
Delivery was more efficient for topics where the teacher felt comfortable	*Students enjoyed the practical activities and the use of real objects in the classroom*	
**There was potential for loss of focus during lesson delivery due to unexpected responses from students*	*The use of practical aids was sometimes distracting since students were more engaged in playing with the objects*	
	Some students did most of the work within their groups while others did very little	

* *Entries requiring dual categorisation*

Table 4.15: Sub-categorisation of emerging themes from teachers' journals (School M)

4.12.1: Summarising categories of emerging themes from teachers' journals (School M)

Upon analysis of issues relating to *teacher development*, it was worth recognising teachers' claims that thinking lessons increased teachers' awareness of the importance of making Mathematics lessons as practical as possible. Although such awareness on its own would not necessarily constitute improved practice, it would probably serve as a driving force for change in practice. In addition, teachers experienced a feeling of satisfaction when every child demonstrated a degree of learning. Further, it must be noted that the thinking lessons assisted in enhancing the level of collaboration among that staff. This might have meant that teachers would be exposed to the experiences of their peers in terms of their successes and limitations, which could potentially improve their practice.

From an analysis of *students' responses*, it was discovered that weaker students were able to show greater participation as a result of increased praise from the teacher. This would most likely mean that weaker students gained self-confidence when they were recognised in the classroom. In addition, it was of interest that students grew in terms of their receptivity to small group activities. This would possibly increase the potential for collaborative learning among students.

On issues representing *the contents of thinking lessons*, teachers were concerned with the challenging nature of thinking lessons both for the teacher and for students. This was not surprising when one considers teachers' statements in the pre-intervention interview. During the pre-intervention interviews, teachers indicated they normally used teaching approaches such as whole class teaching, since it made their task easier. In addition, teachers expressed

concern over the time-consuming nature of thinking lessons. It must be noted that a recurring factor during pre-intervention interviews was the fact that the syllabus had to be completed within a specified period. Since teachers used the teaching approach that would facilitate syllabus completion, as opposed to one that would encourage real learning, then the use of thinking lessons would certainly be an issue of concern in terms of its time-consuming nature.

Teachers' accounts of the thinking lessons were compared with the events during lesson delivery as reflected during structured lesson observations. The following section represents data collected form lesson observations.

4.13: Lesson observations *(School M)*

In order to assess the extent to which teachers' perceptions were in agreement with their classroom practices, a series of lessons were observed *before*, *during* and *after* the intervention period. Hence, a total of six (6) lesson observations were made to each teacher, with *two* conducted during each phase of the research study. Lesson observations comprised a structured as well as a descriptive component (*Appendix N*). The structured component comprised teacher initiated activities, where as the descriptive component comprised a description of some common features of lesson delivery. For the purpose of data presentation, teacher related activities were coded. The following represents an interpretation of the codes presented. (For a full description of teacher related activities as well as raw data for a sample of the teachers under study see *Appendix S*).

CODE	*INTERPRETATION*
Open ended	The use of open ended questions
Closed	The use of closed questions
Probe	An attempt to probe deeper into the responses of students
Praise	Openly praising students for good responses
Challenge	Challenge the responses of students
Build	Build on the responses of students
Small group	Instances of small group activity

- ***Teacher 7MF***

Lessons observations for Teacher **7MF,** revealed some change in practice throughout the research period. There was visible change between pre-intervention lesson delivery and that observed during the intervention phase (Figure 4.11). This was reflected in a rise in the frequency of *open-ended questions* and a subsequent decrease in the use of *closed questions*. There was also an increase in the teacher's *use of praise*, the teacher's ability to *probe responses* and the *use of challenge* in the classroom. However, changes between the intervention phase and the post intervention periods were not as obvious.

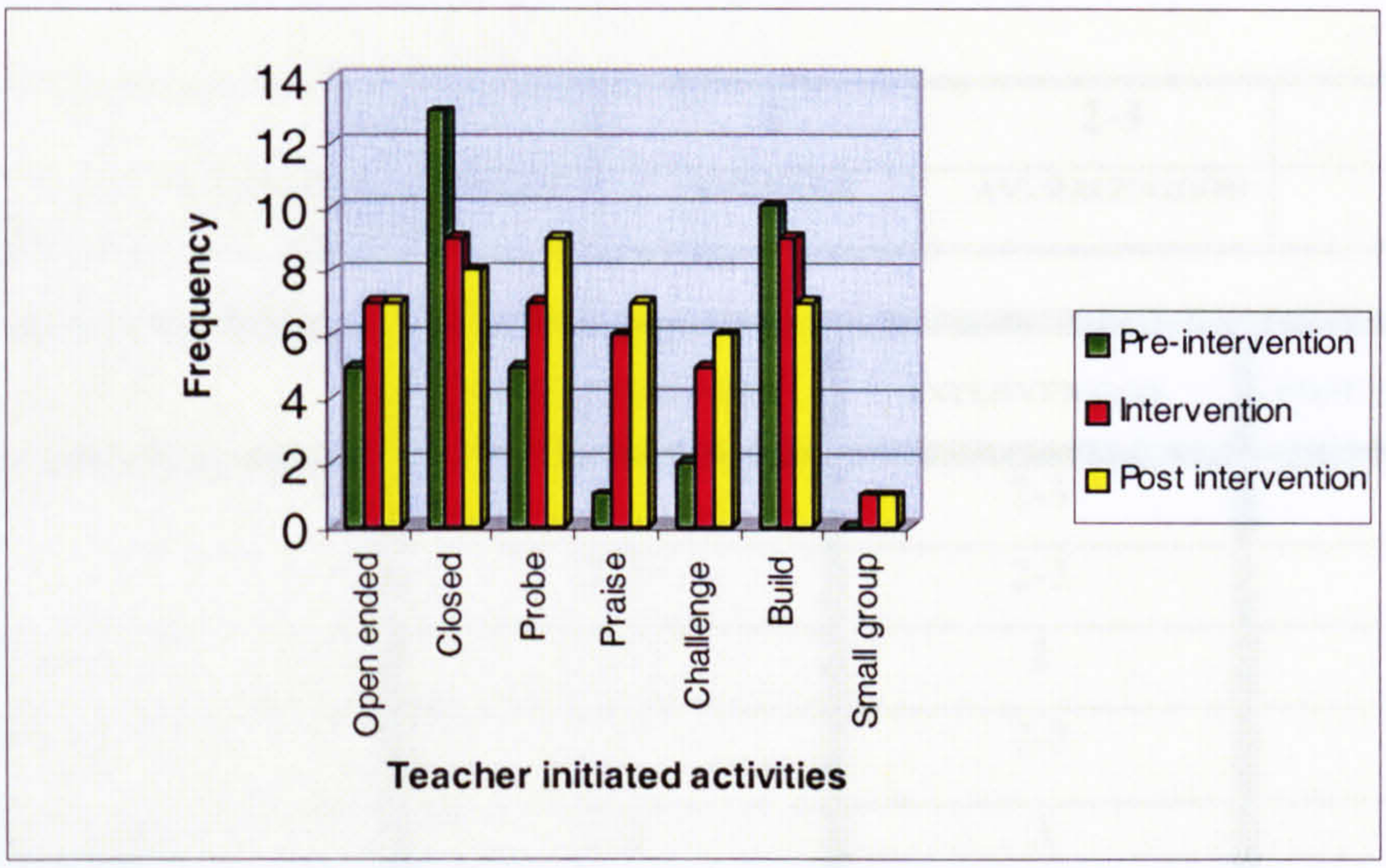

Figure 4.11: Structured observation results (Teacher 7MF, School M)

The descriptive aspects of lesson observation revealed a similar pattern of change. The teacher demonstrated a greater degree of change from pre-intervention to the intervention period as compared with that experienced from the intervention to the post intervention period (Table 4.16). During the pre-intervention phase, the teacher 'needed improvement' in many aspects including the *use of materials*, *lesson summary*, *transfer of learning*, and *the use of diverse problem solving strategies,* among others. However, at the intervention period the teacher obtained 'average' to 'good' ratings in all of the above aspects. There appeared to be a decline in the teacher's performance in some areas since at the post intervention period, she 'needed improvement' in aspects such as '*lesson conclusion*', '*task explanation*' and '*the use of realistic examples*'. One might argue that such decline during the post intervention period might be interpreted as an unconscious attempt by teachers to revert to past practices.

Key:

1	1-2	2	2-3	3
NEEDS IMPROVEMENT	**NEEDS IMPROVEMENT /AVERAGE**	**AVERAGE**	**AVERAGE/GOOD**	**GOOD**

DESCRIPTION	PRE-INTERVENTION	INTERVENTION	POST INTERVENTION
Use of materials	1	2-3	2
Introduction	1-2	2-3	2
Conclusion/summary	1	2	1-2
Transfer of learning	1	2-3	2-3
Use of realistic examples	1-2	3	1-2
Distribution of questions	2-3	2	1-2
Task explanation	2-3	2	1
Diverse problem-solving strategies	1	3	2

Table 4.16: Descriptive aspect of lesson observation (Teacher 7MF, School M)

Teacher 8MF

Teacher **8MF** has shown limited growth in terms of lessons delivery throughout the research period (Figure 4.12). There were only marginal increases in the teacher's *use of open-ended questions*, and in her ability to *challenging students' responses*. The teacher appeared to have used a greater proportion of closed questions as compared to open-ended questions throughout the intervention. The greatest degree of change was an increase in instances of probing.

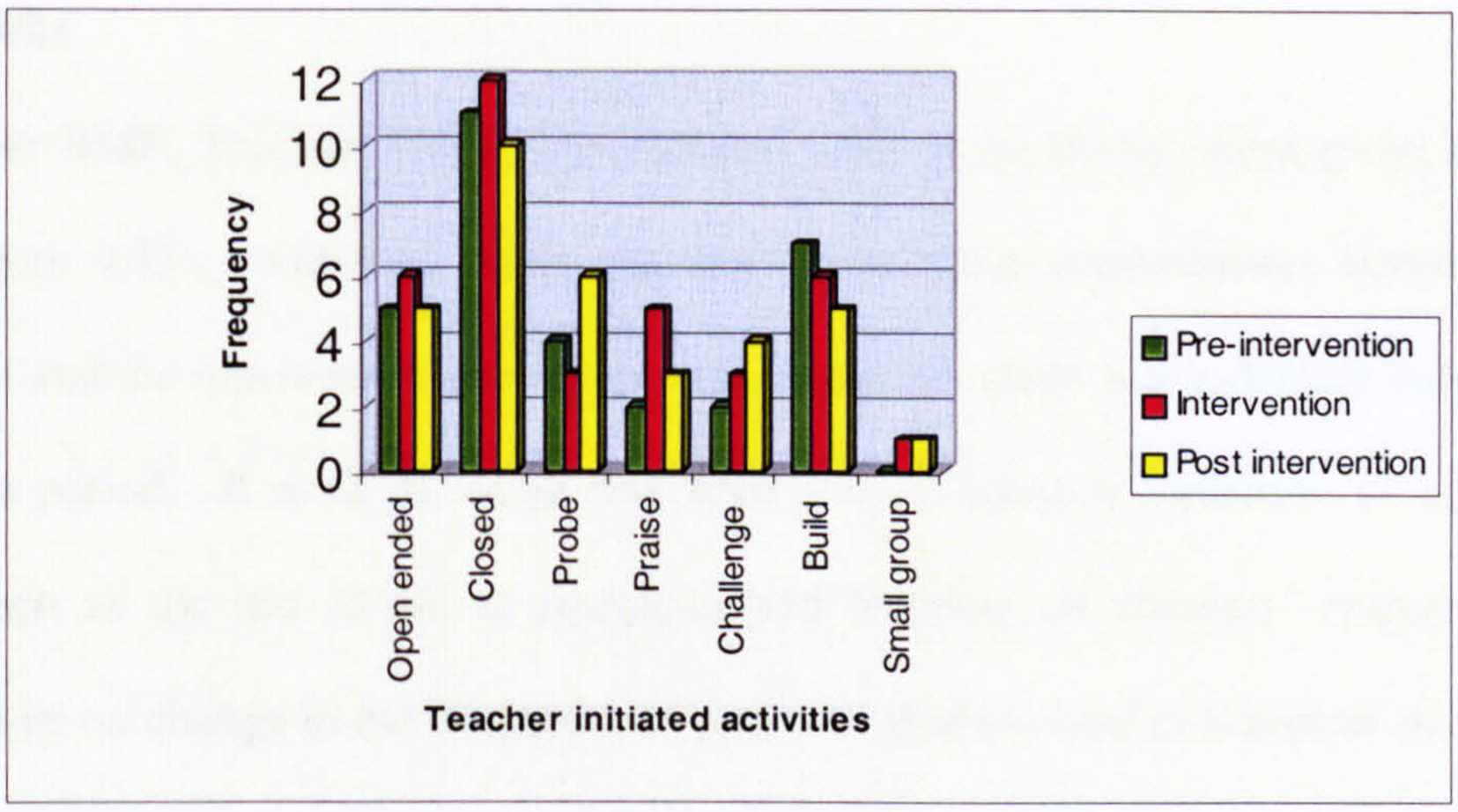

Figure 4.12: Structured observation results (Teacher 8MF, School M)

An analysis of qualitative aspects mirrored the pattern of limited growth and inconsistency in performance from one lesson to the next (Table 4.17). Although there was some improvement in practice, it was not transparently evident as was the case with teacher **7MF**. The teacher maintained an average rating throughout the research period.

Key:

1	1-2	2	2-3	3
NEEDS IMPROVEMENT	**NEEDS IMPROVEMENT /AVERAGE**	**AVERAGE**	**AVERAGE/GOOD**	**GOOD**

DESCRIPTION	PRE-INTERVENTION	INTERVENTION	POST INTERVENTION
Use of materials	1-2	2	2
Introduction	1-2	2	2
Conclusion/summary	1-2	1-2	1
Transfer of learning	1	1	1
Use of realistic examples	1-2	2	2
Distribution of questions	2	1-2	2
Task explanation	2	1	2
Diverse problem-solving strategies	1	2	2

Table 4.17: Descriptive aspect of lesson observation (Teacher 8MF, School M)

Teacher 9MM

Like Teacher **8MF**, Teacher **9MM** demonstrated little or no change throughout the research period (Figure 4.13). Although there appeared to be some improvement between the pre-intervention and the intervention period in many instances, there was a decline during the post intervention period. It must be noted that here was an obvious reduction in less desirable qualities such as the use of *closed questions* and *building on students' responses*. There appeared to be no change in the frequency of praise to students and in instances of small group activity from intervention to post intervention periods.

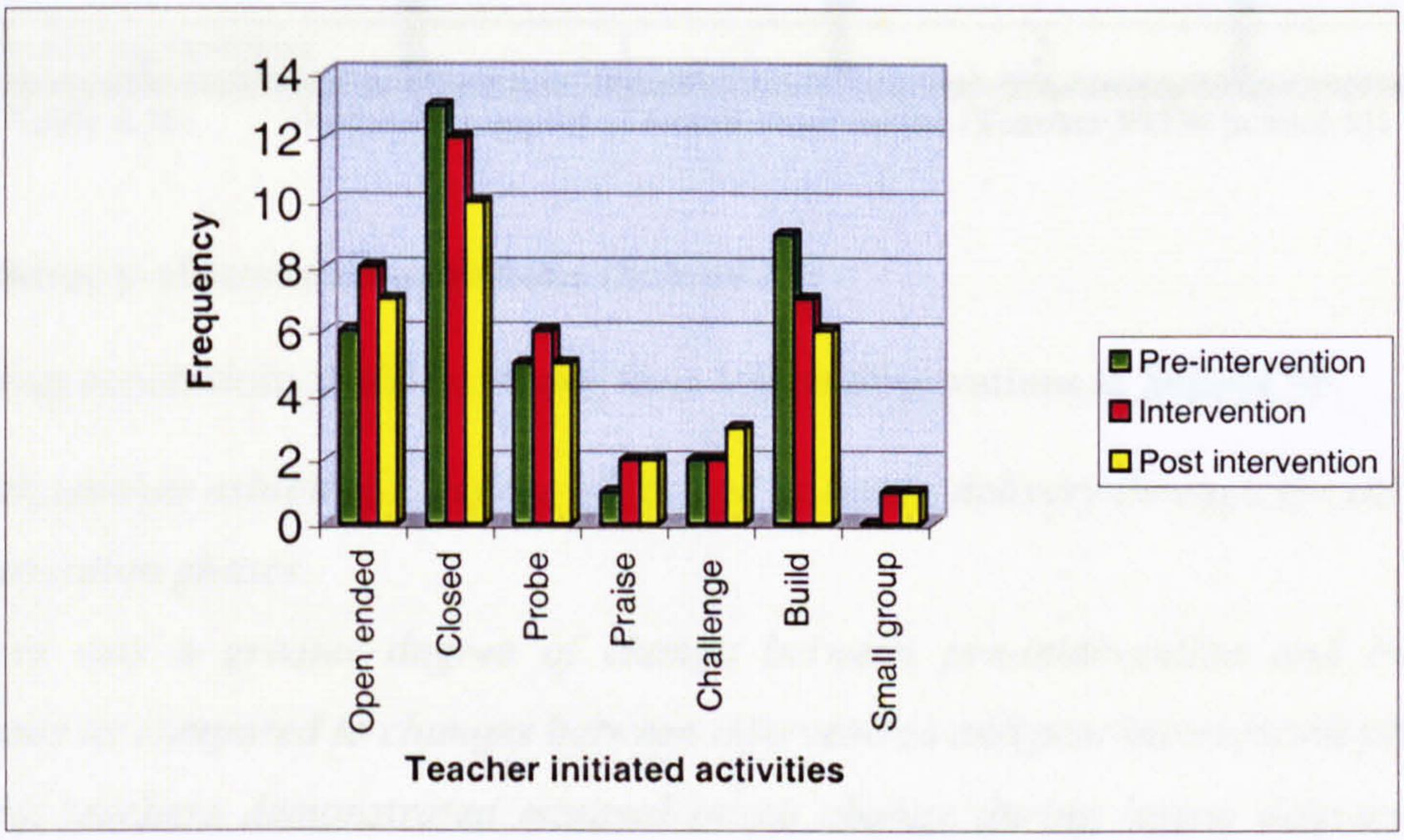

Figure 4.13: Structured observation results (Teacher 9MM School M)

Like structured observation data, the descriptive aspect of lesson observation revealed marginal change in the teacher's practices during the research period (Table 4.18). During the pre-intervention period the teacher generally obtained 'need improvement/average' rating and this was maintained throughout the research period with only marginal changes.

Key:

1	1-2	2	2-3	3
NEEDS IMPROVEMENT	**NEEDS IMPROVEMENT /AVERAGE**	**AVERAGE**	**AVERAGE/GOOD**	**GOOD**

DESCRIPTION	PRE-INTERVENTION	INTERVENTION	POST INTERVENTION
Use of materials	1	2	2
Introduction	1-2	1-2	2
Conclusion/summary	1-2	1	2
Transfer of learning	1-2	1-2	3
Use of realistic examples	1-2	1	1
Distribution of questions	2-3	2	2
Task explanation	2	2	2
Diverse problem-solving strategies	1	2	2

Table 4.18: Descriptive aspect of lesson observation (Teacher 9MM School M)

4.13.1: Summary of lesson observations (School M)

The following conclusions could be drawn from lesson observations at **School M**:

- *Each teacher exhibited a degree of change in lesson delivery through the three lessons observation phases.*
- *There was a greater degree of change between pre-intervention and intervention phases as compared to changes between intervention and post intervention phases.*
- *Some teachers demonstrated minimal or no change during lesson delivery from the intervention to the post intervention phase.*

4.14: Post intervention interviews (School M)

In an effort to determine the extent of potential changes in teachers' beliefs and practices during the intervention period, teachers were again interviewed towards the end of the research study. Issues discussed during post intervention interviews were divided into the following categories.

- *Beliefs on teaching*
- *Teaching practice*
- *Professionalism and professional growth*
- *Teachers' accounts of students' attitude to their teaching*

❖ *Beliefs on teaching*

Teachers were asked to comment on potential changes to their beliefs on the teaching and learning of Mathematics as a result of the innovation. Teacher **7MF** claimed '*...if students are actively involved in the classroom, then they learn better...*' The teacher suggested that practical approaches are '*...good for students but difficult for the teacher...because teachers are not given the required assistance both in terms of training and materials'.* When questioned on her perceptions on whole class teaching, the teacher maintained that whole class teaching was preferred over other methods because she has to '*...ensure that the work is completed...*' However, she admitted that this strategy '*...may not be the best for student learning...*' since students often forgot what was learnt.

On the issue of small group activity, the teacher suggested '*...if students are given a chance to get to learn how to work together, it works well'.* According to the teacher, *'...we assume that the kids should know how to work with each other but now I think that we have to teach them*

that.' She was of the view that teaching students to work together in groups '*...is not part of the Mathematics curriculum*' since this falls under the portfolio of another subject. On the question of challenge, the teacher suggested that '*...kids need to be shown all the possible ways of solving problems so that if they get stuck during exams, they can use the approach that they remembered most vividly*'. She however conceded that '*the examination system does not always allow students to answer in whichever way that they like'.*

When asked whether there were changes in beliefs, Teacher **8MF** claimed to have prior knowledge that interactive strategies work. She suggested that '*...it was all about finding the means and materials to put it in that way*'. She added that '*...if the teacher is not creative enough*' or does not have the time to think about it, he or she will not find it and therefore '*...settle with what may be the fastest and easiest'* way of teaching. The teacher was of the opinion that the ideal learning environment would be '*...a setting where students are taught based on the way that they learn best'*. She however indicated that '*...we cannot do that here so we have to teach all of them together'*. The teacher was convinced that '*...the Education System has to change...'* if any progress is to be made with teaching. She added that all teachers need to be trained and more money needs to be channelled into teaching and learning in order to make a real difference.

The teacher was then asked to give her perceptions on the use of small group activities as an instructional tool. In response to this question she claimed '*...small group activity can work but it takes time, patience, material and expertise*'. She believed such features were hardly present in the current educational environment. From the teacher's remarks it appears that the

Education System of Dominica is partially blamed for teachers' inability to use effective teaching approaches. The teacher felt that the idea of challenge in the classroom '*...sounds perfect in theory...*' but it can be difficult in practice since students are often not ready for such challenge. The preceding responses indicate only marginal change in perception.

On the question of potential changes in beliefs on the teaching and learning of Mathematics, Teacher **9MM** claimed that he had not experienced much change. The teacher indicated that he still had the belief that '*...practice and speed are essential to Mathematics learning'*, although he acknowledged that there are strategies that facilitate practice. The teacher indicated that in the current educational setting, whole class teaching '*...works well for the teacher...*' since '*...small group activity is time consuming...*' and '*...students don't work as effectively as they should...*' when such approach is used.

❖ *Teaching practice*

Teachers were then questioned on their classroom practices in order to assess potential changes in practice due to the intervention. In addition, it was hoped that their responses would establish possible relationships between beliefs and practice after the intervention. Teacher **7MF** described her Mathematics lessons in the past year as '*...mostly direct instruction...*' but she tried on occasions to get students '*...more involved...*'. She indicated that the 'thinking lessons' made a difference in the sense that '*...students were more active...*' and there was more of a hands-on approach during such lessons. The teacher was then asked whether there were potential changes in practice due to the intervention and she conceded '*...trying to teach differently...*'. She however felt that materials and time influenced her efforts and indicated that on occasions '*...it was much easier to go to the class and tell them what to do'*. The

teacher claimed '*...the teaching of thinking skills may be better for students but certainly harder for the teacher in that you have to go out of your way to get stuff to deliver your lesson*'. She used grouping arrangements in order '*...to take care of the weaker ones...*', by grouping students of varying abilities so that the brighter students assist the weaker ones.

Teacher **8MF** believed thinking lessons '*...facilitated multi-level teaching...*' She considered thinking lessons as reinforcement of previous lessons taught on related topics since they were more practical. According to the teacher, while some lessons went well, others were unsuccessful because of '*....lack of formal training*'. Like Teacher **7MF**, Teacher **8MF** admitted to the use of whole group teaching most frequently because she felt '*...that was what worked best...*' in the current education system. The teacher indicated that on most occasions she taught all students together, but like Teacher **7MF**, on some occasions she would allow '*...those who are more advanced to assist the weaker ones*'.

Teacher **9MM** claimed that his lessons were '*...mainly direct instruction with the exception of the thinking lessons'*. He added that he gave students *'...much practice...'* after demonstrating different techniques. The teacher described thinking lessons as **'...***designed to get the students involved...*' He further indicated that such lessons required '*...much more dedication from the teacher...*' because they involved more time and materials; commodities that he felt they rarely possess. The teacher felt that it was '*...difficult to have such lessons all the time...*' since one *'...will not finish the syllabus because it takes too much time'*. He also claimed that it was '*...stressful for the teacher to do these lessons on a day-to-day basis...*' due to small and overcrowded classrooms. Like the other teachers, the teacher admitted to using whole group teaching most often since he claimed that was what he knew best and what he had been

practicing all through his teaching career. The latter statement reiterates the argument that teachers' practices are difficult to change.

❖ *Professionalism and professional growth*

Teachers were questioned on their professional practices in an effort to determine potential changes in their ability to reflect upon, and subsequently improve practice. All teachers were asked to share their opinions on reflective teaching. Teacher **7MF** held the view that she reflected more often during the intervention programme as compared to past years. The teacher suggested that reflection should be a part of teaching because '*...that's the only way that you can help yourself improve'*. She claimed that in as much as there was inadequate support for teachers, in terms of teacher training, teachers have to learn to improve on their own. The teacher further indicated that in the past she did not give much thought to the concept of reflection because '*...the day is filled with different things that the teacher has to do...'* She conceded that it is still difficult to reflect on a daily basis and as such her reflection is limited to occasions when she senses *'...something going wrong'*.

Teacher **8MF** indicated that she attempted to reflect '*...at times...'* but considered time constraints as a deterrent to reflection. Teacher **9MM** held the opinion that teachers should reflect, '*...even if it is not in writing...'*. He argued, on occasions '*...people may not always tell you what you are doing wrong...'*. Therefore, '*...you have to spot your incompetence on your own and do something about it'*. He indicated that his current perception on reflection was different from that held in past years. Teachers were then questioned on the level of collaboration among the staff of the Department. On this issue, all teachers felt that the level

of collaboration was satisfactory. They also admitted to the staff getting closer in the past year in terms of collaboration.

- *Teachers' accounts of students' attitudes to their teaching*

Teachers were then asked to give their perceptions on students' attitudes to the teaching of thinking. Teacher **7MF** claimed students were '*...more relaxed...*' during thinking lessons. She believed the weaker students showed a greater level of participation during such lessons. The teacher attested to an increase in the number of questions asked by students but thought that these questions were mainly related to clarifying instructions during thinking lessons.

Teacher **8MF** felt students interacted more during thinking lessons but on occasions it was difficult to keep them focussed. Teacher **9MM** thought that students talked more among themselves particularly during small group activities. He noted a '*...slight improvement...*' in the length and quality of students' responses since he felt that students were '*...more open with their answers...*' and were '*...more willing to defend their points of view...*' All teachers were of the view that the length of students' responses and their ability to think about lesson contents were dependent on the teaching approach utilised. They also felt that students did not challenge others' responses during lessons since it was not within them to do so.

Based on the responses, one could conclude that there was some change in the students' responses to the instructional technique utilised by the teachers but this change was only marginal and was mainly based on the teacher's instructional style as well as the competencies of individual students.

4.14.1: Summarising post intervention interviews (School M)

MAJOR ISSUES	SUMMARY OF POST INTERVENTION INTERVIEW RESPONSES (SCHOOL M)
Beliefs	When students are actively involved they learn better. Whole class teaching may not be best for student learning but it is the preferred method for teachers because it ensures that the syllabus is completed. The ideal learning environment is one that ensures students are taught in the way they learn best. Small group activity works but it takes time, patience, materials and expertise. Students need to be taught how to work in small groups. Students need to be shown all the possible ways of solving problems.
Practice	Mainly whole class direct instruction was used during teaching because it was much easier to tell students what to do during lessons. During thinking lessons, students were more active. Thinking lessons facilitated multi-level teaching. Thinking lessons were practical. Grouping arrangements were used to cater for weaker students.
Professionalism and professional growth	Reflection should form an active part of teaching because that's the only way in which the teacher can help him/herself improve. It is difficult to reflect on a daily basis due to lack of time. Reflection was only done when a lessons was or exceptionally bad. There was a greater level of staff collaboration during the intervention period.
Teachers' accounts of students' attitudes to their teaching	Students' participation varied from one lesson to the next and from one individual to the next. Students interacted more during thinking lessons but on occasions it was difficult to keep them focussed. Although student responses were less focussed, their answers often showed a different perspective on the issue being discussed.

Table 4.19: Summary of post-intervention interview responses (School M)

4.15: Mapping changes in teachers' beliefs and practices (School M)

As done with **School A**, teachers were mapped on a chart based on the potential changes in beliefs and practices after the active intervention period. However, in order to accurately map teachers on the chart, it was necessary to revisit the pre-intervention data, which acted as a baseline for potential changes in teachers' beliefs and practices.

From an analysis of the data gathered during pre intervention interviews and lesson observations, teachers of **School M** were grouped into two major categories, namely 'behaviourist' and 'social constructivist'. Behaviourist conceptions were considered those relating to *traditional* classroom practices such as rote learning, direct instruction and other methods where the teacher has a high level of control over students' learning. Social constructivists' traditions, related to teaching approaches where students had a greater degree of control over their learning. Such practice would be characterised by a high level of students' interaction, a fair degree of student autonomy and decision–making potential along with the use of a social context for learning. The teachers were then mapped on a grid based on their beliefs and practices prior to the intervention. Figure 4.14 represents the position of each of the teachers of **School M** before the intervention.

65
84
188
265

70
86
188
265

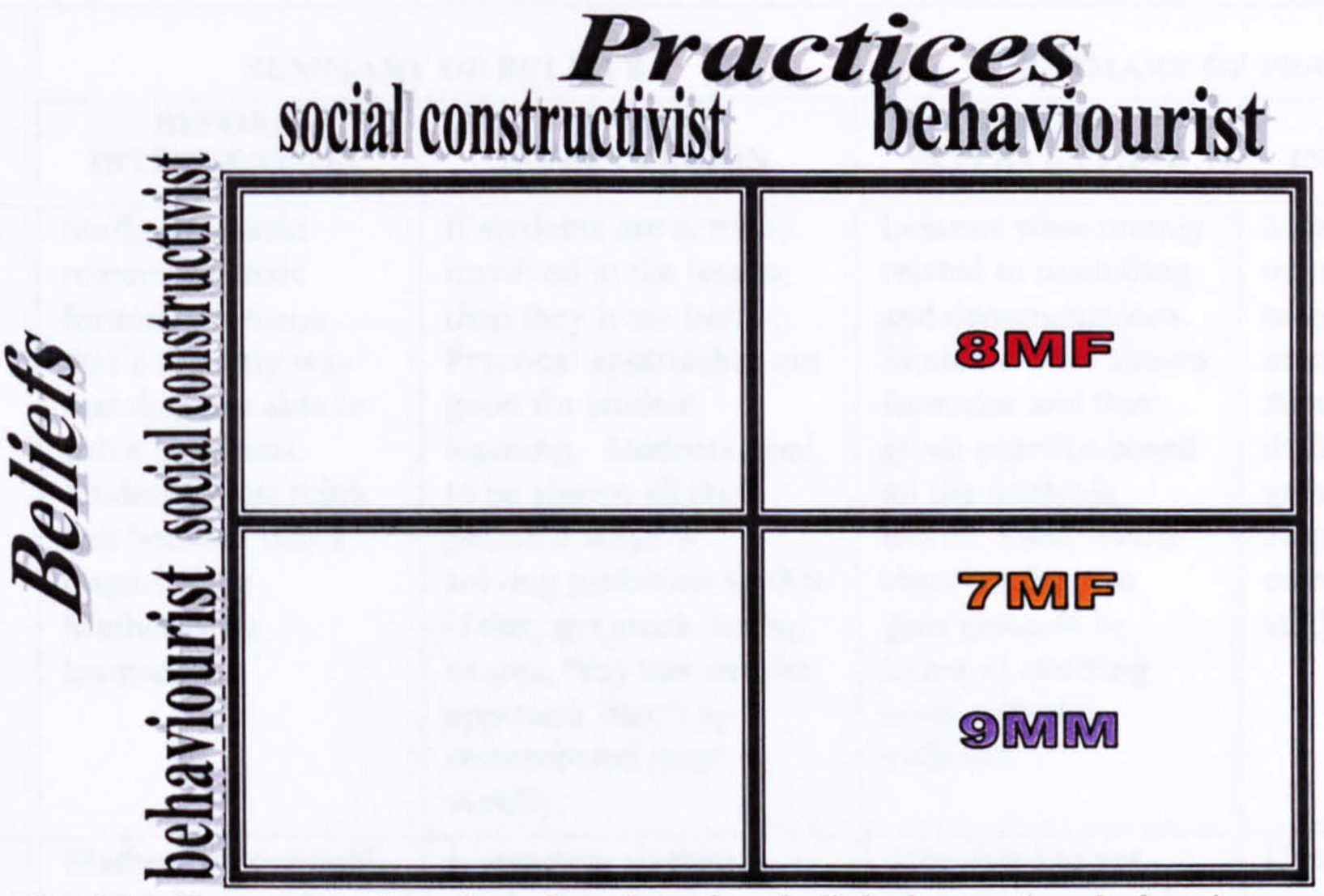

Fig. 4.14: Representation of teachers based on beliefs & practices before intervention (School M)

Key:

Social Constructivist: *Contemporary beliefs and practices*

Behaviourist: *Traditional beliefs and practices*

From the above representation it could be concluded that Teachers **7MF** and **9MM** held behaviourists beliefs and practices prior to the intervention, while Teacher **8MF** held social constructivist beliefs but demonstrated behaviourist practices. Based a summary of the pre and post intervention data (Table 4.20), an attempt was made to assess the degree of change in the beliefs and practices of each of the teachers at School M.

TEACHER CODE & STATUS	SUMMARY OF BELIEFS		SUMMARY OF PRACTICES	
	BEFORE INTERVENTION	AFTER INTERVENTION	BEFORE INTERVENTION	AFTER INTERVENTION
7MF Untrained	Students should remember basic formulas because that's the only way that they are able to solve problems. Students must think fast because that's important in Mathematics learning.	If students are actively involved in the lesson, then they learn better. Practical approaches are good for student learning. Students need to be shown all the possible ways of solving problems so that if they get stuck during exams, they can use the approach that they remembered most vividly.	Lessons were mainly related to modelling and demonstrations. Students were shown formulas and then given practice based on the methods learnt. Used whole class teaching to gain grounds in terms of catching upon with the syllabus.	Mostly direct instruction but tried to get students more involved. Attempted to teach differently. Used grouping arrangements to cater for the weaker students.
8MF Untrained	Mathematics should be hands-on. The classroom should be a learning environment and students should enjoy doing the subject.	Interactive strategies work. The ideal learning environment is a setting where students are taught based on the way that they learn best. Small group activity works but it takes time, patience, materials and expertise.	Attempted to get students involved by using various problems and activities. Helped students discover certain things but often used students' text for teaching. Used whole class teaching due to time constraints..	Used whole group teaching most frequently because it worked best. On some occasions allowed students who are more advanced to assist others.
9MM Untrained	Students should be given time to practice both in the classroom and at home. Students should be told that they must have a certain pace because it is not only about getting the answers right but how fast you can get them.	Practice and speed are essential to Mathematics learning. Whole class teaching works well for the teacher since small group activity is time consuming and students don't work as effectively as they should.	Used the textbook for teaching. Used whole class teaching most often.	Used mainly whole group, direct instruction. Gave students practice after demonstrating different techniques.

Table 4.20: Summary of pre and post intervention beliefs and practices (School M)

Based on an analysis of the pre and post intervention data gathered, one could conclude that there were limited changes in the beliefs and practices of the teachers at **School M**. An attempt was made to represent the *approximate* degree of change in teachers' beliefs and practices on a chart (Figure 4.15), which was intended to serve only as a guide to potential changes. The

greatest degree of change was seen in the beliefs and practices of Teacher **7MF**. Teacher **8MF** experienced the least change in beliefs, while Teacher **9MM** experienced the least change in practice. As observed from pre-intervention interview responses, Teacher **8MF** already held social constructivists beliefs on the teaching and learning of Mathematics.

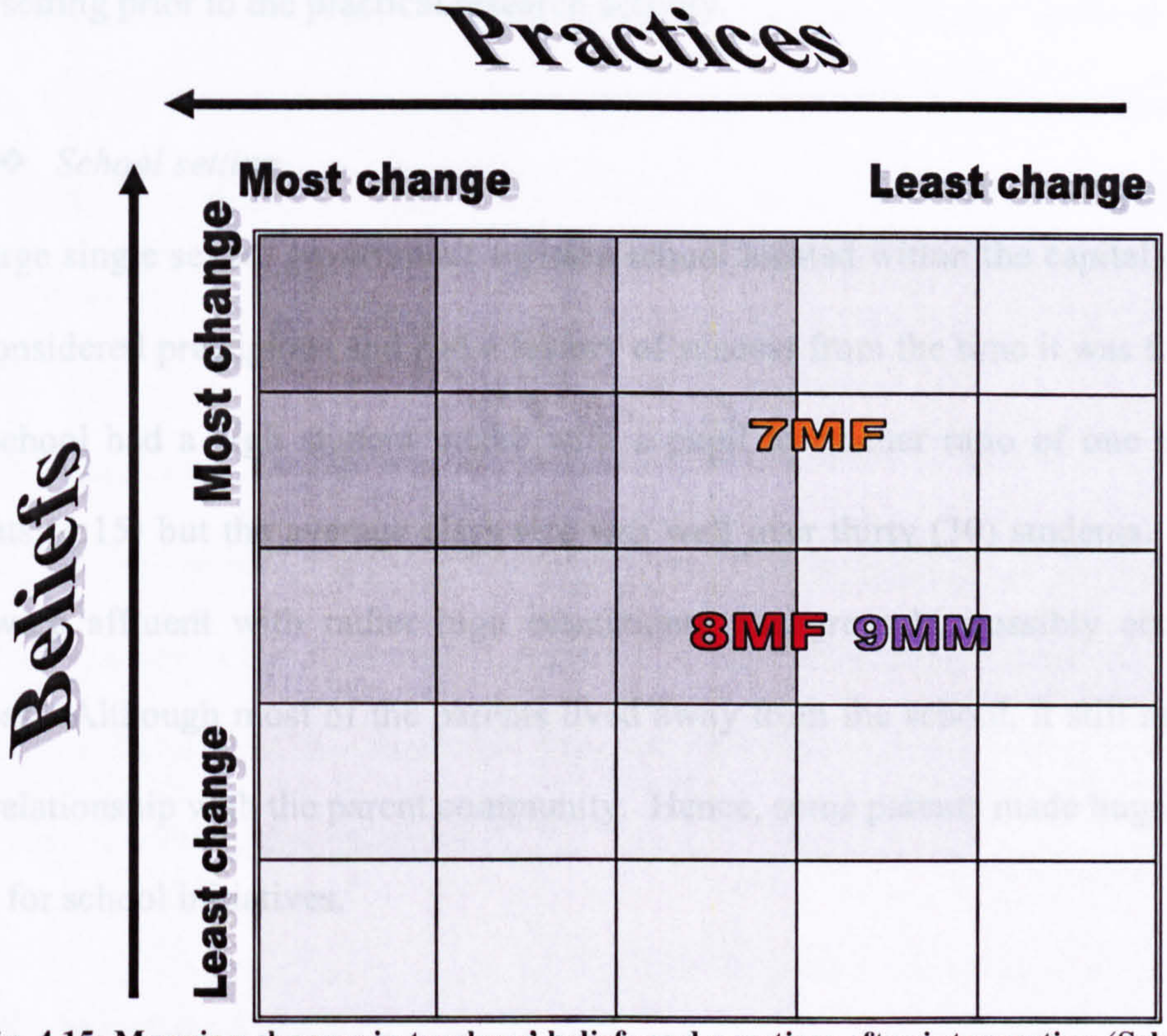

Fig. 4.15: Mapping changes in teachers' beliefs and practices after intervention (School M)

4.16: (Case 3) Describing School C prior to the research study

As done with previous schools, each teacher of **School C** was assigned a code comprising numbers in chronological order (**10-19**), the school code (**C**) and the teacher's sex (**M** or **F**). Hence, the first female teacher of this school was coded **19CF**. The following is a description of the school setting prior to the practical research activity.

❖ *School setting*

This was a large single sexed, government-assisted school located within the capital city. The school was considered prestigious and had a history of success from the time it was founded in 1858. The school had a high student intake with a pupil to teacher ratio of one teacher to fifteen students (1:15) but the average class size was well over thirty (30) students. Many of the parents were affluent with rather high educational backgrounds, possibly encouraging student success. Although most of the parents lived away from the school, it still maintained an excellent relationship with the parent community. Hence, some parents made huge financial contributions for school initiatives.

❖ *Principal and staff*

The school principal had been in this position for decades and appeared to have *technical awareness* on the successful running of the school. There appeared to be a collegial relationship between the staff and principal. Teachers came from various backgrounds and locations around the island and from other neighbouring islands. In comparison to the other schools under study, a greater proportion of teachers from this school were formally trained. However, there was a huge difference in the level of experience of the staff. This was made explicit when one considered the staff of the Mathematics Department where approximately

one half of the teachers had over four years experience and formal teacher training, whereas the other half were totally new to teaching (Table 4.21).

❖ *Students*

Enrolment at the school was based upon student performance on the national entrance examination as well as the religious background of parents. Hence, although students' cultural backgrounds might have differed slightly, many were of the same religious background and were to a great extent homogeneous.

❖ *Classroom setting*

Although many of the teachers were qualified, there was still the tradition of placing students in rows with the teacher at the front of the room. The extremely large classes at this school might have further encouraged this tradition. Irrespective of the extremely large classes at the school, there were few discipline problems.

❖ *School performance*

Student performance was high since the school maintained the tradition of topping the regional examinations success lists in most subjects in past years (Henry 2001). There was the traditional perception that ill disciplined students usually changed once they enrolled at the school. Hence, it appeared that the school had the power of shaping students both in terms of discipline and performance.

4.16.1: Teachers' profiles

A profile of the teachers was obtained in order to have a clearer picture of each teacher's perceptions and actions (Table 4.21).

CODE	POSITION	EXPERIENCE	TRAINING
10CF	Classroom teacher	13 years	BSc. Major Accounting, Minor Mathematics
11CF	Head of Department	10 years	Bachelors in Computing Science BEd. Secondary Teaching
12CM	Classroom teacher	10 years	Bachelors in Biology
13CM	Classroom teacher	10 years	None
14CM	Classroom teacher	4 years	None
15CF	Classroom teacher	1 year	None
16CF	Classroom teacher	1 year	None
17CF	Classroom teacher	1 year	None
18CF	Classroom teacher	1 year	None
19CF	Classroom teacher	1 year	None

Table 4.21: Teachers profile (School C)

From Table 4.21, there appeared to be a transparent difference between experienced and inexperienced teachers. Most experienced teachers had ten years (10) experience or greater, whereas the inexperienced teachers for the most part had less than one year experience at the beginning of the research study. An informal rapport with the teachers revealed that the main reason for such disparity in experience was the fact that in most cases, new teachers were those who excelled in their college years and therefore they considered one or two years teaching experience as a stepping stone to further studies.

As done with prior schools, interview data from **School C** was divided into two categories namely pre and post intervention data. Pre-intervention data was intended to establish baseline information pertinent to the teachers under study, whereas post intervention data was intended to assess the degree of change in teachers after the intervention. The data was sub-divided into the following categories:

- *Beliefs on teaching*
- *Teaching practice*
- *Professionalism and professional growth*
- *Teachers' accounts of students' attitudes to their teaching*

4.17: Pre-intervention interviews (School C)

❖ *Beliefs on teaching*

Teachers were asked to give their opinions on how Mathematics should be taught and learnt.

Teacher **10CF** was of the view that '*...Maths should be practical...*' and '*...teaching should be related to real events...*' She also suggested '*...students should be encouraged to discover solutions for themselves'*. Teacher **11CF** shared similar sentiments in her perceptions that Mathematics teaching '*...should be action-oriented...*' According to the teacher, students should be allowed to actively participate in the lesson and try to discover methods or formulas to solve problems. According to the teacher '*...the Mathematics classroom should be like a little laboratory where students discover things and feel a sense of belonging...*'

There were other teachers with a slightly similar perception of Mathematics teaching and learning. Teacher **12CM** believed Mathematics lessons '*...should be exciting*'...and '*...students should feel relaxed in the classroom and they should grow to love the subject...*

The teacher added that lesson contents '*...should be related to real-life examples...*' The above viewpoints were supported by Teacher **13CM** since he felt that Mathematics teaching '*...should be related to enjoyment...*' According to the teacher, '*...students should be shown that they are doing the subject, not only for the knowledge but also for the fun of it...*' Teacher **14CM** was also in agreement in his perception that Mathematics teaching should be '*...down-to-earth, fun and exciting...*' He also believed '*...students should be allowed to think and to practice methods of solving problems'*. Other teachers, however, equated effective teaching and learning with a strong emphasis practice. This was most obvious in the responses of Teachers **15CF, 16CF, 17CF, 18CF** and **19CF** who believed '*...students would only do well if they practice using the exercises in their text...'*

The teachers were asked to give their perceptions on small group activity and although they felt that the idea of small group activities was good in theory, they were all opposed to the idea of using this strategy frequently in the classroom. Teacher **10CF** indicated that small group activity is a noisy and time-consuming exercise since students '*...spend more time moving their chairs...*' She added, '*...during group presentations, students can't agree on anything...*' This was supported by a number of teachers including Teachers **13CM, 14CM, 18CF** and **19CF.** According to Teacher **13CM,** '*...when one has a group of students preparing for external examinations, you don't have the luxury of time to engage in time-consuming activities...*' Teacher **18CF** added, '*...the teacher can probably cover three topics in the time that he or she would take to do the small group activity...'*

Like the preceding teachers, Teachers **11CF 12CM, 15CF** and **17CF** were not in favour of small group activity as an instructional tool but for slightly different reasons. Teacher **12CM** indicated '*...students take group work as a social thing and a time to talk rather than to work...*' According to Teachers **11CF**, '*...when students are working together, you don't know what they can do individually...*' Teacher **15CF** added '*...students look up to individual students within the group to get the answer each time...*' Teacher **17CF** further supported the above with the suggestion that '*...students don't work as hard as they should and they wait for one person to do all the hard work...*'

All teachers were fully in support of whole class teaching as a suitable teaching approach within their educational context. They felt the approach assists in maintaining classroom control and the direction and pace of the lesson as well as saving on teaching time. Teacher **10CM** believed '*...whole class teaching is the best method from a teacher's perspective'...* since *'...under the current constraints the use of any other approach would be a major sacrifice...*' Teacher **12CM** felt that whole class teaching was a preferred method because with the use of this approach, '*...the teacher has more control...*' Teacher **14CM** conceded, through the whole class teaching approach, '*...the teacher is able to predict with some certainty how long a lesson or unit will take...*' It was interesting that Teacher **15CF** acknowledged that with the whole class approach '*...students don't remember the stuff...*' but she felt that this was attributed to students' poor memory.

Teachers were then asked to give their perceptions on challenge. All teachers were in favour of the use of challenge in the classroom. According to Teacher **10CF**, '*...challenge creates a*

better learning environment in that students know what's right and what's wrong so they don't just stick to a point…' Teacher **15CF** claimed that although it is good to challenge students, they '*…never rise to the challenge'*… since they only use the solution that the teacher gives. Teacher **16CF** added, students are often reluctant to provide their own responses '*…because they want to get all the answers from the teacher…'* Both Teachers **18CF** and **19CF** were of the view that it is almost useless to challenge students because '*…they are expected to use specific procedures…'* during external examinations.

A summary of teachers' beliefs on the teaching and learning of Mathematics before the intervention revealed:

- *Untrained and inexperienced teachers emphasised the need for practice and memorisation of facts.*
- *Trained and experienced teachers felt Math teaching should be student oriented.*
- *Most teachers were not supportive of small group activity as an instructional tool.*
- *Whole class teaching was the preferred teaching approach by all teachers.*
- *All teachers supported the idea of challenge but some conceded that students are not always prepared to accept challenge in the classroom.*

❖ *Teaching Practice*

Teachers were asked a series of questions pertinent to their practice in order to assess the level of congruence between beliefs and practices. They were firstly asked to describe their Mathematics lessons. To this question, all teachers described, what could be considered a traditional teaching approach. The teachers claimed they explained methods of solving problems and allowed students to practice exercises using these methods. Teachers **10CF** and **13CM** claimed to use demonstrations and step-by-step procedures during Mathematics

teaching. They indicated that this approach was utilised due to time constraints and other school pressures.

Teacher **11CF** described her Mathematics lessons as mainly explaining. She would, on most occasions, '*...introduce a topic, explain formulas, give examples, and then ask a few students to come up on the board to try them...*' The teacher admitted that the latter strategy was not the ideal but it worked for the short term. She was of the view that it was the best strategy considering the current educational context.

Teachers were then asked to state their methods of catering for students with varied abilities. Teachers **10CF, 13CM** and **18CF** claimed to identify weaker students and pair them with brighter ones, while Teachers **11CF, 15CF** and **16CF** worked individually with weaker students while the others were engaged. Teachers **12CM, 14CM, 17CF** and **19CF,** on the other hand, pitched lessons at the average group with the hopes that every child would '*...get something...*' from the lesson.

On the question of challenging lessons, many teachers equated difficulty with challenge. These teachers indicated that students often complain the work is difficult and they are barely able to cope with the existing content. Hence, they considered the subject adequately challenging.

A summary of teachers' practices revealed the following:

- *Teachers did not teach in the way they thought Mathematics should be taught.*
- *Teachers taught Mathematics by explanation followed by practice.*

- *Trained teachers considered time constraints, lack of materials and pressures of completing the syllabus as reasons for their current teaching approach.*
- *Untrained teachers cited lack of training as the main reason for their teaching approach.*
- *The teachers catered for students with varying abilities using a range of methods.*
- *Teachers equated difficulty with challenge.*

❖ *Professionalism and professional growth*

Teachers were asked to give their perceptions on professional growth. All teachers indicated that there was continuous improvement in practice. Some felt that improvement was in the area of teaching methods, some admitted to improvement in lesson contents, while others, felt that there was greater improvement in their ability to manage students' behaviour.

The teachers were then asked whether there were occasions when they would consider the successes and limitations of their practice. Most teachers reflected to some extent, though not formally. There was a general perception among the inexperienced teachers that reflection was non-existent due to inadequate time to fully reflect on practice. However, all teachers indicated that they learn from their mistakes on a daily basis and constantly strive to get better at teaching by capitalising on their strengths.

Since collaboration among peers assists in improving practice, teachers were asked whether they took time out to share classroom experience with their colleagues. To this question all teachers indicated that there was a high degree of collaboration among the staff. The teachers felt that they did not always collaborate on a formal basis but they informally discussed

teaching and learning issues in the staffroom. In addition, the teachers claimed that they shared teaching materials with colleagues.

- *Teachers' accounts of students' attitudes to their teaching*

Teachers were then asked to give their perceptions of students' attitudes to their teaching and most teachers felt that student interaction was minimal. Some teachers were of the view that students would talk among themselves about issues not related to the lesson contents but they were generally reluctant to discuss learning issues openly. The teachers claimed that the length and quality of students' responses as well as their ability to think about the contents of lesson was dependent on individual students and on the lesson content. They were of the view that students rarely challenged others or asked questions in class.

4.18: Teachers' journals (School C)

The data collected from teacher's journals were analysed using coding categories comprising common or unique features along with the relationship between features, as derived from the data itself. As seen with other schools, teachers' journal entries were not directly related to the guidelines provided for data collection and as such entries were made on various issues based on teachers' perceptions of lesson delivery. From a detailed analysis of the journals, a number of recurrent themes emerged. Emerging themes were divided into three categories based on their relevance to different aspects of teaching and learning. Hence the following three categories were established:

- *Aspects relating to teacher development*
- *Aspect relating to students' responses*
- *Aspects relating to the contents of thinking lessons.*

Concerns relating to *teacher development* focussed on aspects that impacted on teachers' professional growth. Those relating to *students' responses* focussed on students' reactions and patterns of interaction, whereas issues pertinent to *the contents of thinking lessons* measured teachers' impressions on the effectiveness of thinking lessons (Table 4.22).

ASPECTS RELATING TO TEACHER DEVELOPMENT	ASPECTS RELATING TO STUDENTS' RESPONSES	ASPECTS RELATING TO LESSON CONTENTS
Delivery did not always go as planned. *Lessons raised teachers' awareness of the need for reflection.* *Lessons encouraged more focussed discussions with the Mathematics Department.* *Lesson delivery was challenging for the teacher.* *Using a greater proportion of open-ended questions was more difficult than expected.* *Lessons demanded more classroom management skills.* *Classroom space limitations affected grouping arrangements.* **Thinking lessons constituted a level of threat in terms of teacher competence.*	*Group work was a challenge because of different personalities and student abilities.* *Some students made greater contributions to group activities than others.* *Students enjoyed using the activity sheets provided* *Students came up with unexpected responses.* *On occasions the level of student competition shifted from the individual to the group.* *An increase in praise meant an increase in the level of responses by reserved students.* *Students were often much noisier than normal.* *Students constantly attempted to obtain teachers' opinions as to whether they were on the right track* *Increase in the use of open-ended questions meant increase in detailed student responses.* *Increase in students' thinking time meant more relevant responses.* *All students were able to work at their level and benefited in some way from the lessons.* *Students enjoyed using concrete learning aids.* *Students had better memory of past thinking lessons than memory of normal lessons* *Students discovered a variety of problem-solving approaches.*	*There was inadequate time to complete the lesson in most instances.* *Activity sheets assisted in independent learning.* *Some lessons had to be modified to meet curriculum demands.* **Thinking lessons constituted a level of threat in terms of teacher competence.*

* Entries requiring dual categorisation

Table 4.22: Sub-categorisation of emerging themes from teachers' journals (School C)

4.18.1: Summarising categories of emerging themes obtained from teachers' journals

- *Issues representing teacher development*

A detailed analysis of journal entries revealed teachers were concerned about the degree of challenge posed by the teaching of thinking lessons, particularly in aspects of classroom management during group work. Teachers felt that the use of a greater proportion of open-ended questions was a challenge. Hence, they conceded that the lessons constituted a degree of threat to their level of classroom control. It was worth noting that teachers recognised some positive attributes relating to the teaching of thinking. They were of the view that the lessons demonstrated the need for adequate teacher planning and they assisted in raising their awareness of the need to reflect on practice.

- *Issues representing students' responses*

A number of interesting observations were made with respect to students' responses. At some point during the delivery of thinking lessons, teachers felt the focus of competition shifted from the individual to the group level. This might have been due to a traditionally competitive atmosphere in many classrooms. Teachers indicated that students constantly attempted to solicit their perceptions as to whether they were on the right track. Such practice might have been attributed to the fact that students were not familiar with a high degree of autonomy and were used to getting detailed guidance from teachers. It was also worth noting teachers' claims that all students benefited in some way from the thinking lessons. Since the objective of teaching is to achieve a degree of learning from every child, this could be considered an essential attribute.

❖ *Issues representing the contents of thinking lessons*

There were a number of teacher concerns relating to the contents of thinking lessons. Firstly, teachers felt that thinking lessons were time consuming. This would certainly have been an area of concern because on many occasions during pre-intervention interviews, teachers felt that there was inadequate time to complete the school curriculum. Teachers also recognised a number of positive features with regards to lesson contents. They were of the view that activity sheets assisted in independent learning and this generated interest in the lessons.

4.19: Lesson observations

In an attempt to determine the degree of consistency between teachers' journal accounts and their actual practice, a series of lessons observations were conducted. Hence, each teacher was observed on six (6) separate occasions at different phases of the research study. Lesson observations considered solely teacher related activities and the categories included both positive and negative features. Observations were divided into two categories namely, a structured and a descriptive component (*Appendix N*). The structured component comprised an average of the occurrences for the two lessons observed during each phase of the intervention, while the descriptive component comprised a rating scale. The following is a summary of lesson observations for the teachers of **School C.**

- ***Teacher 10CF***

As seen from the structured observation data, Teacher **10CF** demonstrated constant improvement in all aspects of delivery from pre-intervention to post intervention phases. There was an increase in occurrences of desirable aspects such as *open-ended questions*, *probing*

responses and *praise to students*, with a subsequent decrease in less desirable aspects such as the *use of closed questions* (Fig. 4.16). There appeared to have been no change between pre-intervention and intervention scores in the teacher's use of *challenge* and in *probing students' responses.*

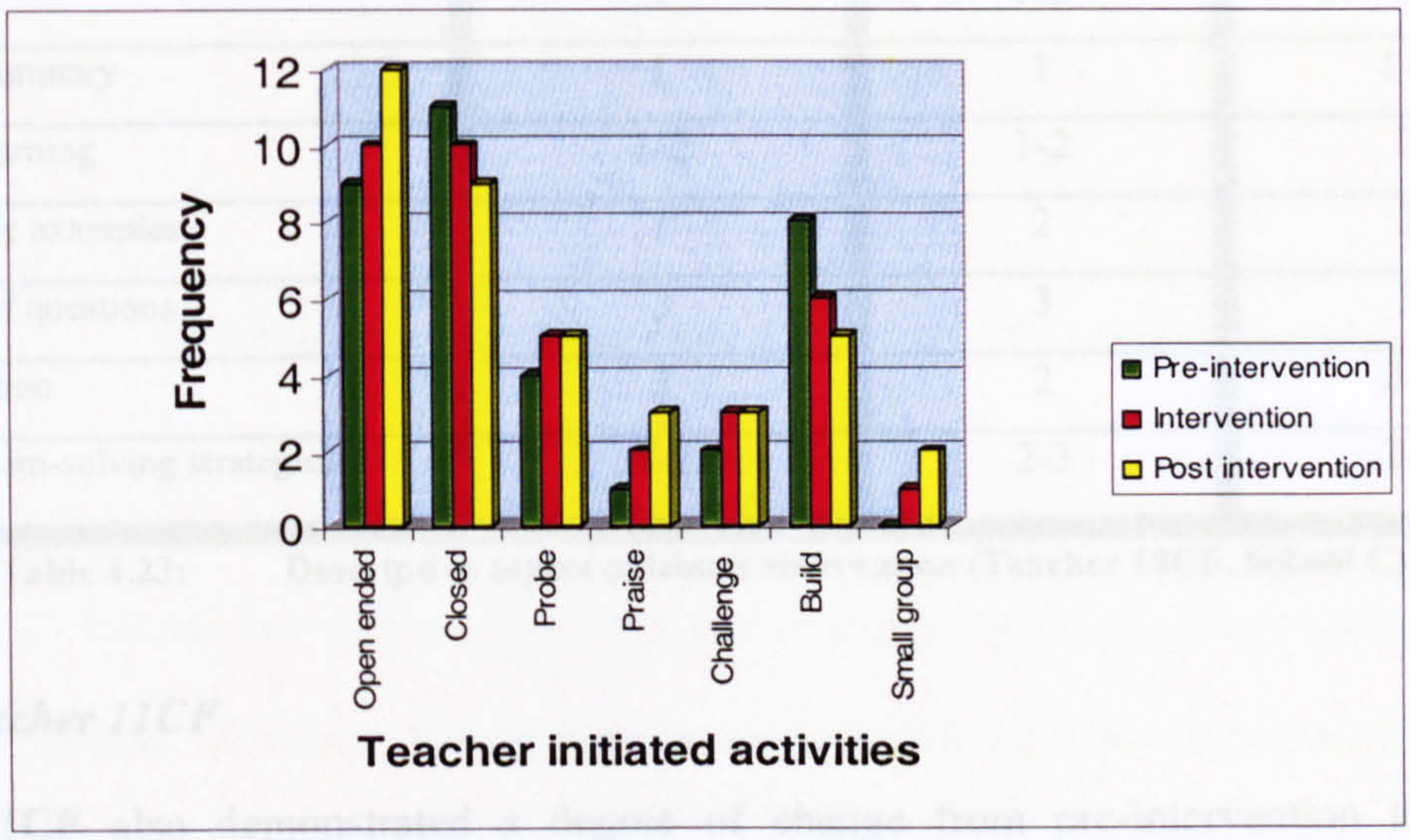

Figure 4.16: Structured observation results (Teacher 10CF, School C)

Descriptive data also revealed similar changes. However, there appeared to be greater change during the post intervention phase of the descriptive observation as compared to that observed during structured observations. The greatest degree of improvement was seen in *lesson introduction* (Table 4.23). It was interesting that the teacher maintained a 'good' performance in the *use of materials*, *distribution of questions* and *task explanation* during all phases of observation.

Key:

1	1-2	2	2-3	3
NEEDS IMPROVEMENT	**NEEDS IMPROVEMENT /AVERAGE**	**AVERAGE**	**AVERAGE/GOOD**	**GOOD**

DESCRIPTION	PRE-INTERVENTION	INTERVENTION	POST INTERVENTION
Use of materials	2	3	3
Introduction	1	1-2	3
Conclusion/summary	1	1	1-2
Transfer of learning	1-2	1-2	2
Use of realistic examples	1	2	2
Distribution of questions	3	3	3
Task explanation	3	2	2-3
Diverse problem-solving strategies	1-2	2-3	2-3

Table 4.23: Descriptive aspect of lesson observation (Teacher 10CF, School C)

- ***Teacher 11CF***

Teacher **11CF** also demonstrated a degree of change from pre-intervention to the post intervention period (Fig. 4.17). It was interesting to note that there were no instances of *praise to students* or *small group activity* during the pre-intervention period. However, during intervention and post intervention periods, these aspects were considered during lesson delivery.

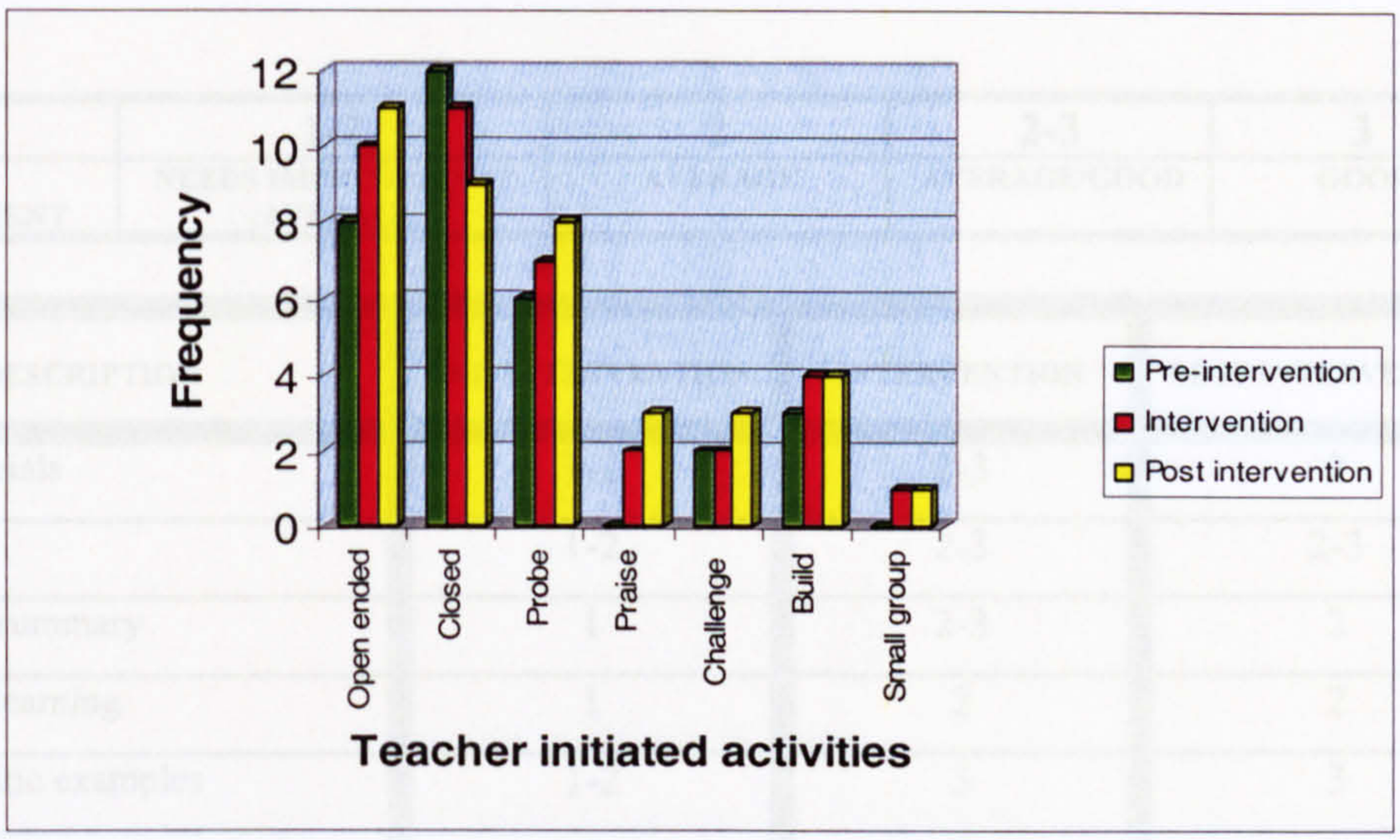

Figure 4.17: Structured observation results (Teacher 11CF, School C)

Descriptive data revealed a slightly greater degree of change than the structured observation (Table 4.24). The teacher 'needed improvement' in many aspects of delivery during the pre-intervention period. However, during intervention and post intervention periods there was an 'average' to 'good' rating in most aspects. It is worth noting, as seen with other observations the teacher obtained a 'good' rating in *task explanation* and the *distribution of questions* even before active intervention. The latter might have been due to the fact that the methods of whole class direct instruction, which is practiced by most of the teachers observed, places a heavy emphasis on task explanation.

Key:

1	1-2	2	2-3	3
NEEDS IMPROVEMENT	**NEEDS IMPROVEMENT /AVERAGE**	**AVERAGE**	**AVERAGE/GOOD**	**GOOD**

DESCRIPTION	PRE-INTERVENTION	INTERVENTION	POST INTERVENTION
Use of materials	1-2	2-3	2
Introduction	1-2	2-3	2-3
Conclusion/summary	1	2-3	2
Transfer of learning	1	2	2
Use of realistic examples	1-2	3	3
Distribution of questions	3	3	3
Task explanation	3	2	2-3
Diverse problem-solving strategies	1	2-3	2

Table 4.24: Descriptive aspect of lesson observation (Teacher 11CF, School C)

- ***Teacher 12CM***

Like Teacher **11CF**, Teacher **12CM** has demonstrated a notable degree of improvement in many areas throughout the intervention period (Fig. 4.18). It was of interest that the teacher did not *praise students' responses* during the pre-intervention period. Like the other teachers, there were no instances of small group activity during the pre-intervention phase. This might have been attributed to the whole group teaching approach that was frequently utilised.

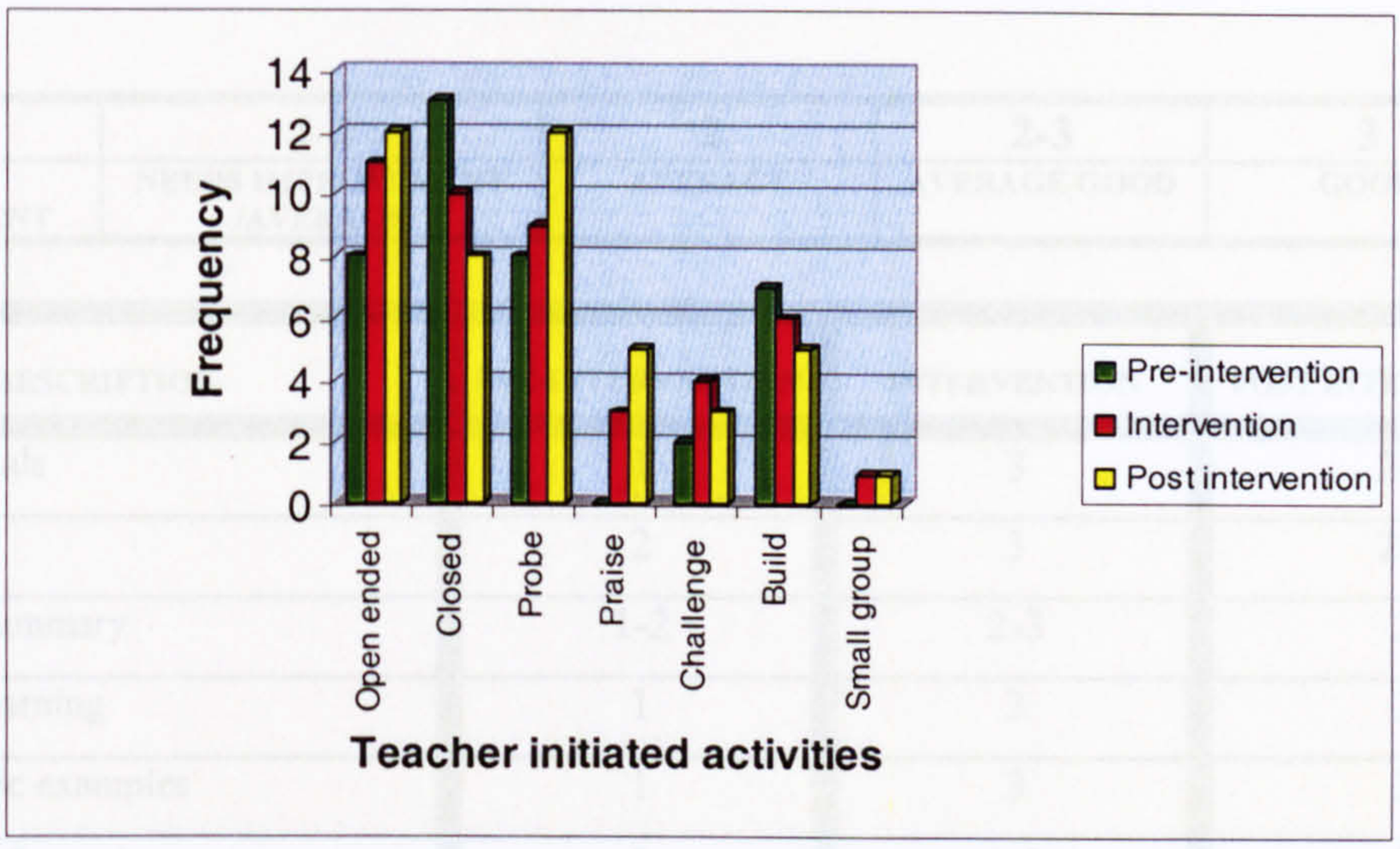

Figure 4.18: Structured observation results (Teacher 12CM, School C)

Descriptive data revealed a similar pattern of improvement in most aspects of lesson delivery. However, there appeared to be a greater level of change in many areas between the pre-intervention and the intervention phase as compared to that experienced between the intervention and post intervention phases (Table 4.25). It was of interest that there appeared to be a reduction in the efficiency in *the distribution of questions* and in *task explanation* from 'good' rating during the pre-intervention phase to 'average' to 'good' rating during the intervention period. This might have been due to the fact that by nature, teachers' unfamiliarity with this method of teaching would mean a certain degree of difficulty in lesson explanation.

Key:

1	1-2	2	2-3	3
NEEDS IMPROVEMENT	**NEEDS IMPROVEMENT /AVERAGE**	**AVERAGE**	**AVERAGE/GOOD**	**GOOD**

DESCRIPTION	PRE-INTERVENTION	INTERVENTION	POST INTERVENTION
Use of materials	1	3	2-3
Introduction	2	3	2-3
Conclusion/summary	1-2	2-3	2
Transfer of learning	1	3	3
Use of realistic examples	1	3	2
Distribution of questions	3	2-3	3
Task explanation	3	2	2-3
Diverse problem-solving strategies	1	3	2

Table 4.25: Descriptive aspect of lesson observation (Teacher 12CM, School C)

- ***Teacher 13CM***

Like Teacher **12CM**, Teacher **13M** failed to *praise students' responses* during the pre-intervention phase (Fig. 4.18). The teacher demonstrated a high degree of growth in the use of open-ended questions and in a subsequent reduction in the frequency of closed questions. There was also obvious improvement in the teacher's ability to challenge students' responses, thus setting the pace for an increase in student thinking.

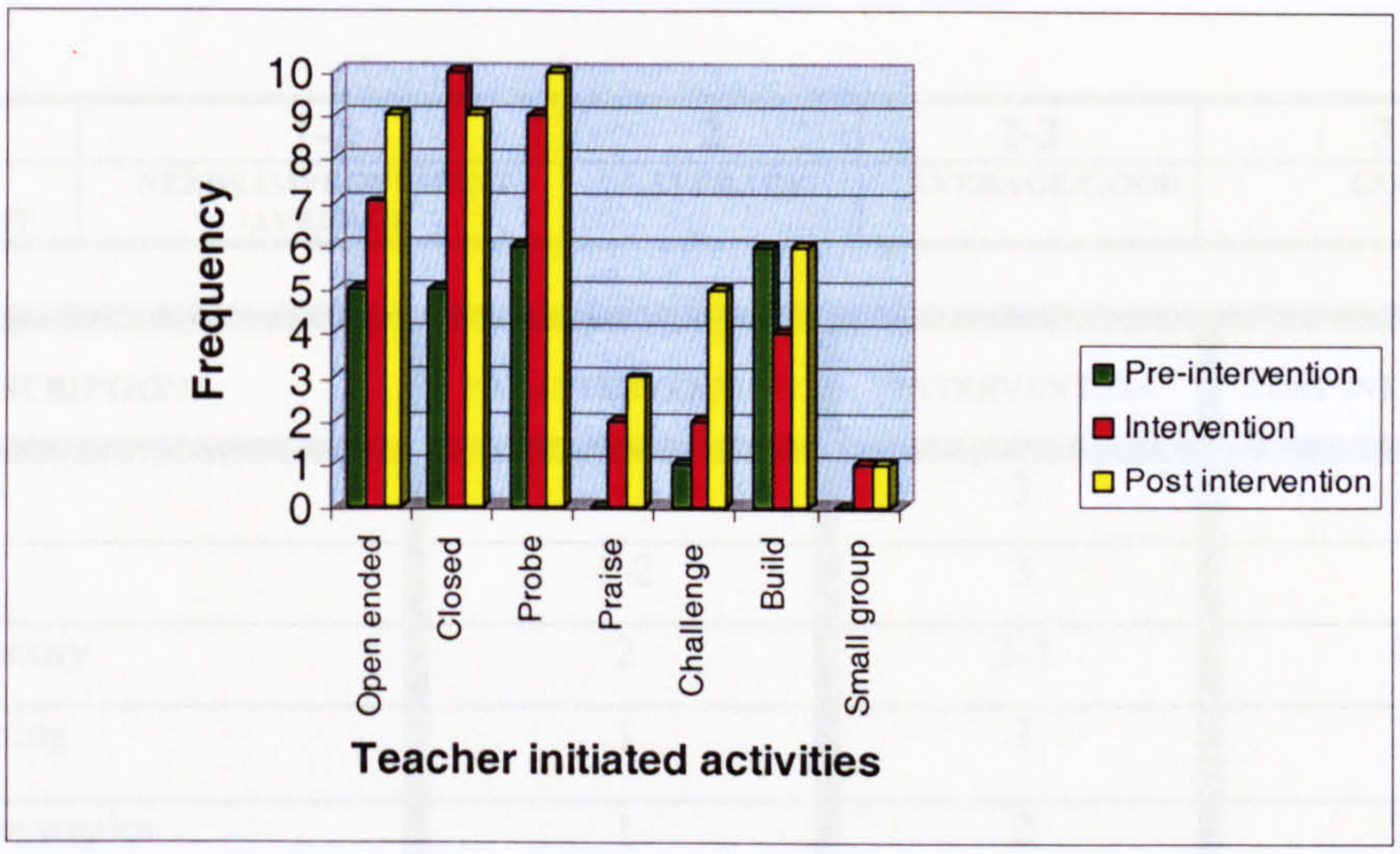

Figure 4.19: Structured observation results (Teacher 13CM, School C)

Descriptive data points to a degree of growth in all aspects of lesson delivery. However, there seemed to have been greater increase from pre-intervention to intervention periods (Table 4.26).

The descriptive results were slightly different from the structured observation results in that there was almost no change in the teacher's performance from the intervention to the post intervention phase. Like many of the other teachers, the teacher demonstrated a degree of mastery in *distribution of questions* and *task explanation* prior to the intervention period.

Key:

1	1-2	2	2-3	3
NEEDS IMPROVEMENT	**NEEDS IMPROVEMENT /AVERAGE**	**AVERAGE**	**AVERAGE/GOOD**	**GOOD**

DESCRIPTION	PRE-INTERVENTION	INTERVENTION	POST INTERVENTION
Use of materials	1	3	2-3
Introduction	1-2	3	3
Conclusion/summary	2	2-3	2-3
Transfer of learning	1	3	2-3
Use of realistic examples	1	2	2-3
Distribution of questions	3	2	3
Task explanation	3	1-2	1-2
Diverse problem-solving strategies	1	3	2-3

Table 4.26: Descriptive aspect of lesson observation (Teacher 13CM, School C)

- ***Teacher 14CM***

Teacher **14CM** demonstrated a limited degree of growth from pre-intervention to the intervention phase and almost no growth from the intervention to the post intervention phase in many aspects of delivery (Fig. 4.20). There were few instances of *challenge* throughout the research study and no instance of *praise to students* or the use of *small group activity* at the pre-intervention phase.

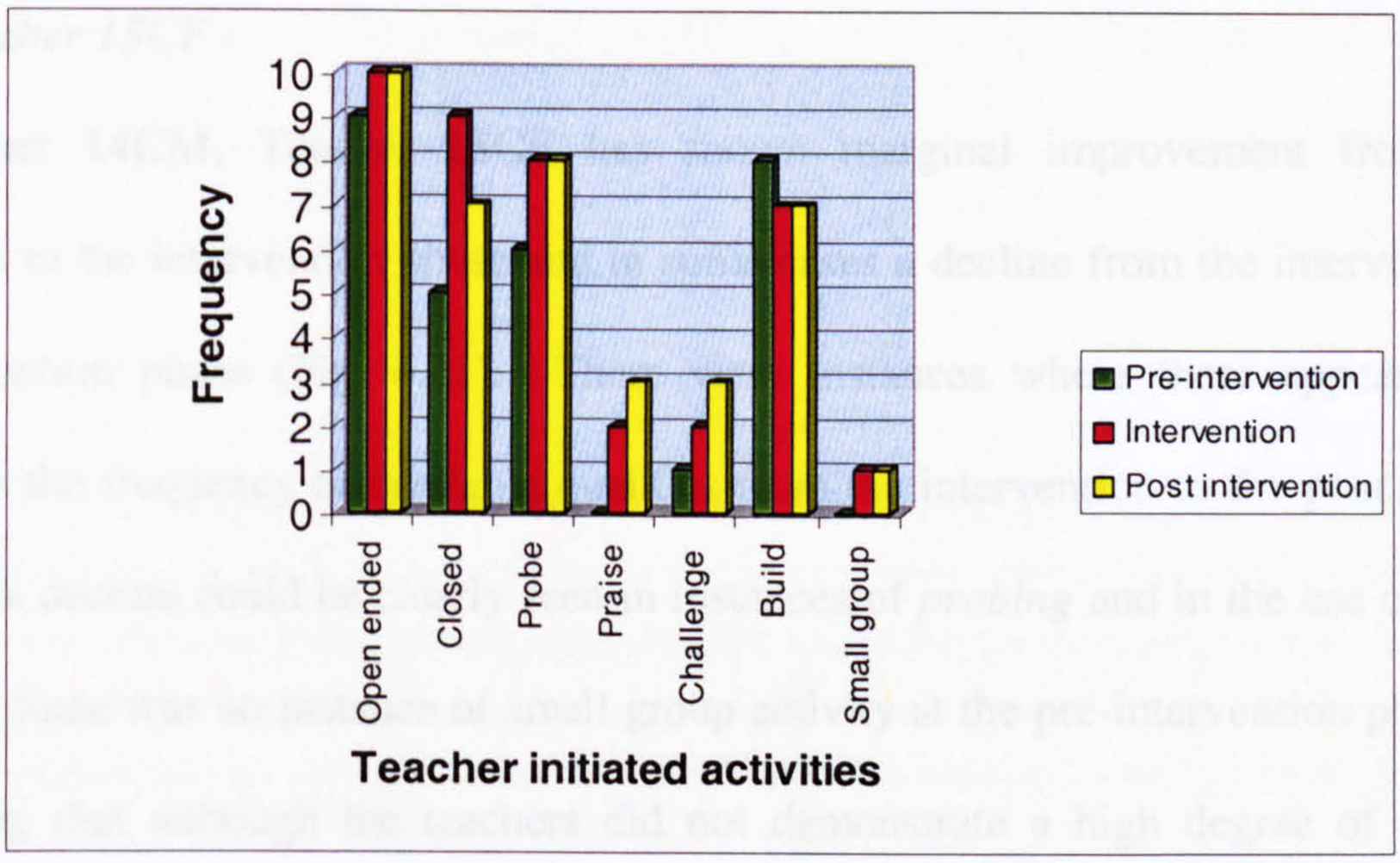

Figure 4.20: Structured observation results (Teacher 14CM, School C)

The descriptive data revealed a similar pattern of improvement from pre-intervention to intervention periods and a subsequent decline in performance in most areas during the post intervention phase (Table 4.27). The teacher appeared to have maintained a high rating in the distribution of questions in all lessons observed.

Key:

1	1-2	2	2-3	3
NEEDS IMPROVEMENT	NEEDS IMPROVEMENT /AVERAGE	AVERAGE	AVERAGE/GOOD	GOOD

DESCRIPTION	PRE-INTERVENTION	INTERVENTION	POST INTERVENTION
Use of materials	1	3	2
Introduction	1-2	3	2-3
Conclusion/summary	2	2	2
Transfer of learning	1	2-3	2
Use of realistic examples	1	2-3	2
Distribution of questions	2-3	3	3
Task explanation	3	1-2	2
Diverse problem-solving strategies	1	3	2-3

Table 4.27: Descriptive aspect of lesson observation (Teacher 14CM, School C)

- ***Teacher 15CF***

Like Teacher **14CM**, Teacher **15CF** has shown marginal improvement from the pre-intervention to the intervention phase and in some cases a decline from the intervention to the post intervention phase (Fig. 4.21). There were instances where there appeared to be a reduction in the frequency of desirable qualities from the intervention to the post intervention period. This decline could be clearly seen in instances of *probing* and in the use of *challenge.* In addition, there was no instance of small group activity at the pre-intervention phase. It was worth noting that although the teachers did not demonstrate a high degree of change, she maintained an exceptionally high score from the pre-intervention to post intervention period.

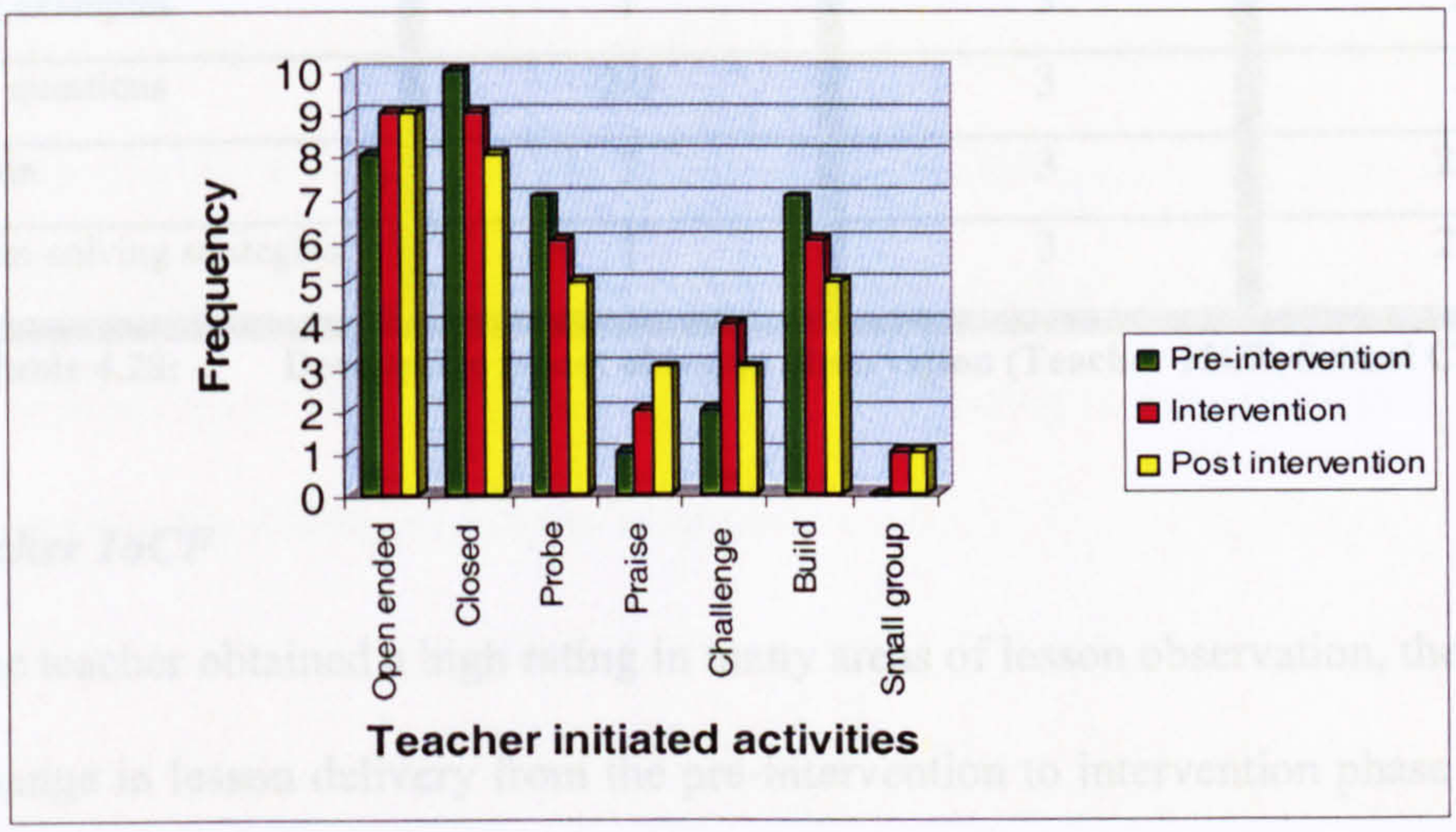

Figure 4.21: Structured observation results (Teacher 15CF, School C)

Like many of the other teachers observed, Teacher **15CF** demonstrated competence in the *distribution of questions* and in *task explanation* during all the lessons observed (Table 4.28). During the pre-intervention period, the teacher was weak in the *use of realistic examples* and in

the *use of diverse problem solving strategies*. However, there was improvement in these areas at the intervention post and intervention phases.

Key:

1	1-2	2	2-3	3
NEEDS IMPROVEMENT	**NEEDS IMPROVEMENT /AVERAGE**	**AVERAGE**	**AVERAGE/GOOD**	**GOOD**

DESCRIPTION	PRE-INTERVENTION	INTERVENTION	POST INTERVENTION
Use of materials	1-2	3	2-3
Introduction	1-2	3	3
Conclusion/summary	2	2-3	2
Transfer of learning	1	2-3	2
Use of realistic examples	1	3	2
Distribution of questions	2-3	3	3
Task explanation	3	3	2-3
Diverse problem-solving strategies	1	3	2-3

Table 4.28: Descriptive aspect of lesson observation (Teacher 15CF, School C)

- ***Teacher 16CF***

Although the teacher obtained a high rating in many areas of lesson observation, there was only marginal change in lesson delivery from the pre-intervention to intervention phase (Fig. 4.22). During the post intervention phase, there was no definite improvement and in many cases there was a decline. This was more obvious in areas such as *probing students' responses* and the teacher's *use of challenge* in the classroom. The teacher also demonstrated change in terms of a much higher total in the proportion of *closed questions* as compared to the number of *open-ended* questions asked during all phases of lesson observation.

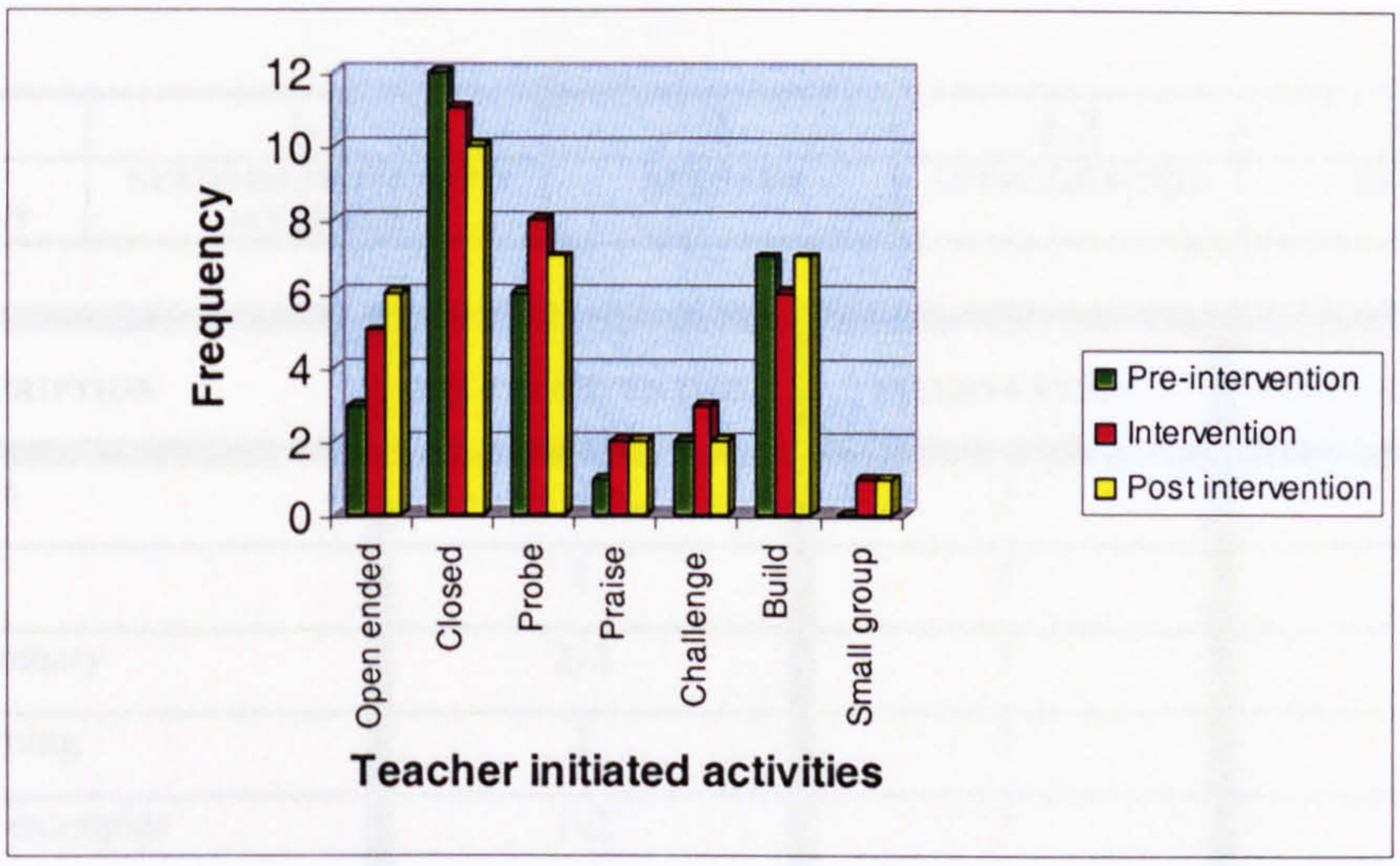

Figure 4.22: Structured observation results (Teacher 16CF, School C)

Descriptive data revealed a slightly different pattern since the teacher improved on all aspects of delivery from pre-intervention to intervention phases but appeared to decline in performance during the post intervention period (Fig. 4.29). One possible reason for such decline might have been a reduction in active support during this period. Like all the other teachers observed, the teacher appeared to have maintained a relatively good rating in the *distribution of questions* and in *task explanation* during all lessons observed.

Key:

1	1-2	2	2-3	3
NEEDS IMPROVEMENT	**NEEDS IMPROVEMENT /AVERAGE**	**AVERAGE**	**AVERAGE/GOOD**	**GOOD**

DESCRIPTION	PRE-INTERVENTION	INTERVENTION	POST INTERVENTION
Use of materials	1	3	2
Introduction	1	3	2
Conclusion/summary	2-3	2	1
Transfer of learning	1	3	2-3
Use of realistic examples	1-2	3	2
Distribution of questions	3	2-3	2-3
Task explanation	3	3	2
Diverse problem-solving strategies	1	3	2-3

Table 4.29: Descriptive aspect of lesson observation (Teacher 16CF, School C)

- ***Teacher 17CF***

Like Teachers **15CF** and **16CF**, this teacher has shown little change in lesson delivery between the pre-intervention and intervention phases and no change during the post intervention period (Fig 4.23). In addition, there was a high proportion of *open-ended* and *closed questions* during all lessons observed. There were only limited instances of *challenge* and *praise to students* during all lesson observed. In addition, like all of the other teachers, there was no instance of *small group activity* during the pre-intervention phase.

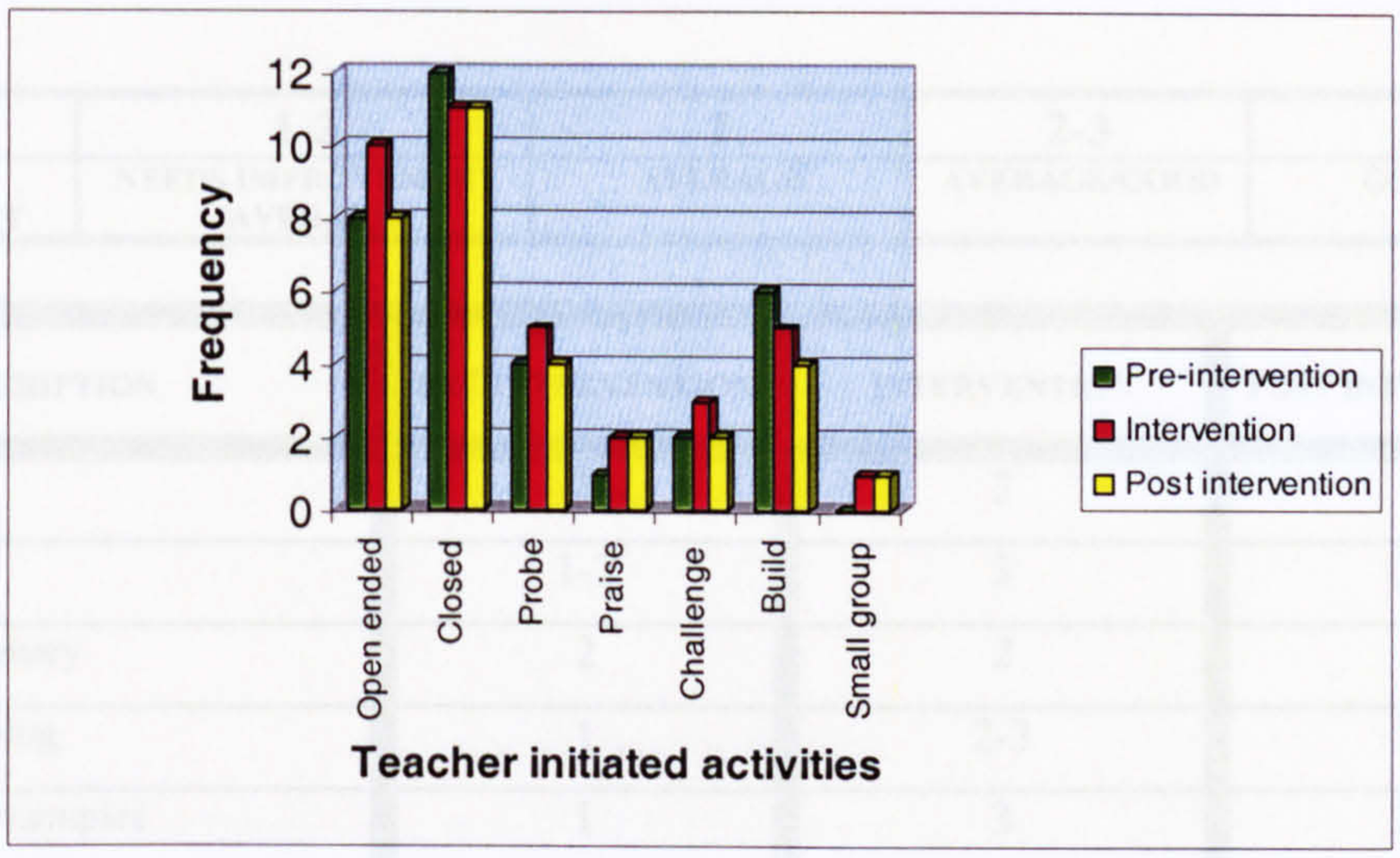

Figure 4.23: Structured observation results (Teacher 17CF, School C)

Descriptive observation results revealed change in performance from the pre-intervention to the post intervention phase (Table 4.30). However, there appeared to be a greater degree of change between pre-intervention and intervention periods as compared to that made between intervention and post intervention periods. As seen with other teachers, the teacher also obtained 'average' to 'good' rating in *task explanation* and in *distribution of questions* throughout lesson observations.

Key:

1	1-2	2	2-3	3
NEEDS IMPROVEMENT	**NEEDS IMPROVEMENT /AVERAGE**	**AVERAGE**	**AVERAGE/GOOD**	**GOOD**

DESCRIPTION	PRE-INTERVENTION	INTERVENTION	POST INTERVENTION
Use of materials	1	3	3
Introduction	1-2	3	2-3
Conclusion/summary	2	2	1-2
Transfer of learning	1	2-3	2-3
Use of realistic examples	1	3	2-3
Distribution of questions	3	2	3
Task explanation	3	2-3	2
Diverse problem-solving strategies	1	3	2-3

Table 4.30: Descriptive aspect of lesson observation (Teacher 17CF, School C)

- ***Teacher 18CF***

This teacher demonstrated a degree of inconsistency during lesson delivery in the lessons observed (Fig. 4.24). There were limited instances of *probing responses*, *praise* and the use of *small group activities* throughout the lesson observation period. The teacher also appeared to use a greater proportion of *closed questions* as opposed to *open-ended* questions during all phases of lesson observation. It appeared that there was slight change between pre-intervention and post intervention ratings and even less change in many areas between pre-intervention and intervention phases.

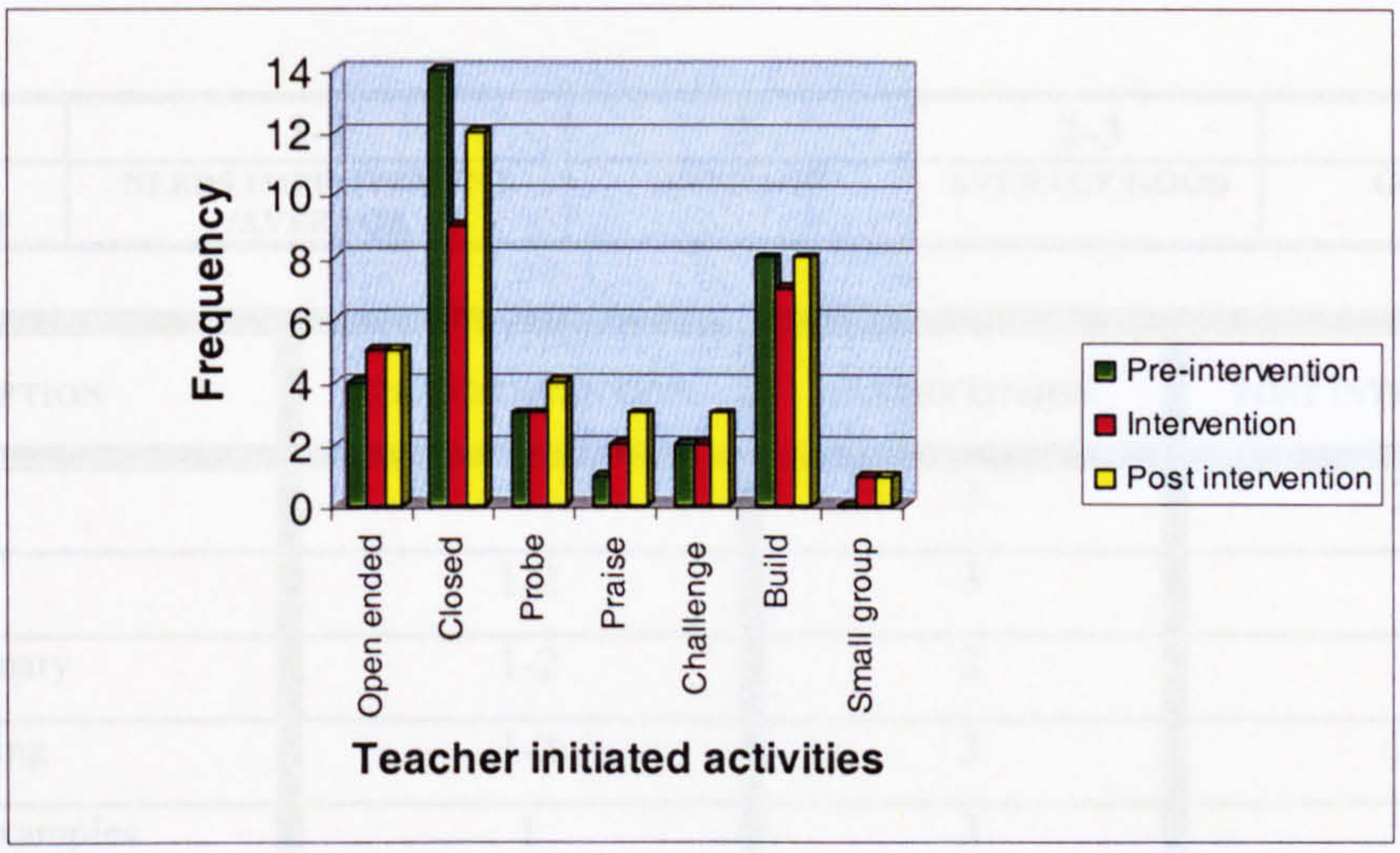

Figure 4.24: Structured observation results (Teacher 18CF School C)

Descriptive results were slightly different in that there was a degree of change from the pre-intervention to the intervention period. However, there was very little change between the intervention and the post intervention phases (Table 4.31). In comparison with the other teachers observed, the teacher was not as competent in *task explanation* and *distribution of questions* during the pre-intervention period.

Key:

1	1-2	2	2-3	3
NEEDS IMPROVEMENT	**NEEDS IMPROVEMENT /AVERAGE**	**AVERAGE**	**AVERAGE/GOOD**	**GOOD**

DESCRIPTION	PRE-INTERVENTION	INTERVENTION	POST INTERVENTION
Use of materials	1	3	2-3
Introduction	1-2	3	3
Conclusion/summary	1-2	2	2
Transfer of learning	1-2	3	2-3
Use of realistic examples	1	3	3
Distribution of questions	2	2	1
Task explanation	1	1	2
Diverse problem-solving strategi	1	2-3	2-3

Table 4.31: Descriptive aspect of lesson observation (Teacher 18CF, School C)

- ***Teacher 19CF***

There was no definite pattern of change in the lesson delivery of Teacher **19CF** throughout the observation period (Fig. 4.25). It must be noted that the teacher obtained a high score in most of the areas observed during all phases of the innovation. As seen with many of the other teachers, there were limited occurrences of *praise* and *challenge*. In addition, there was no instance of *small group activity* during the pre-intervention phase.

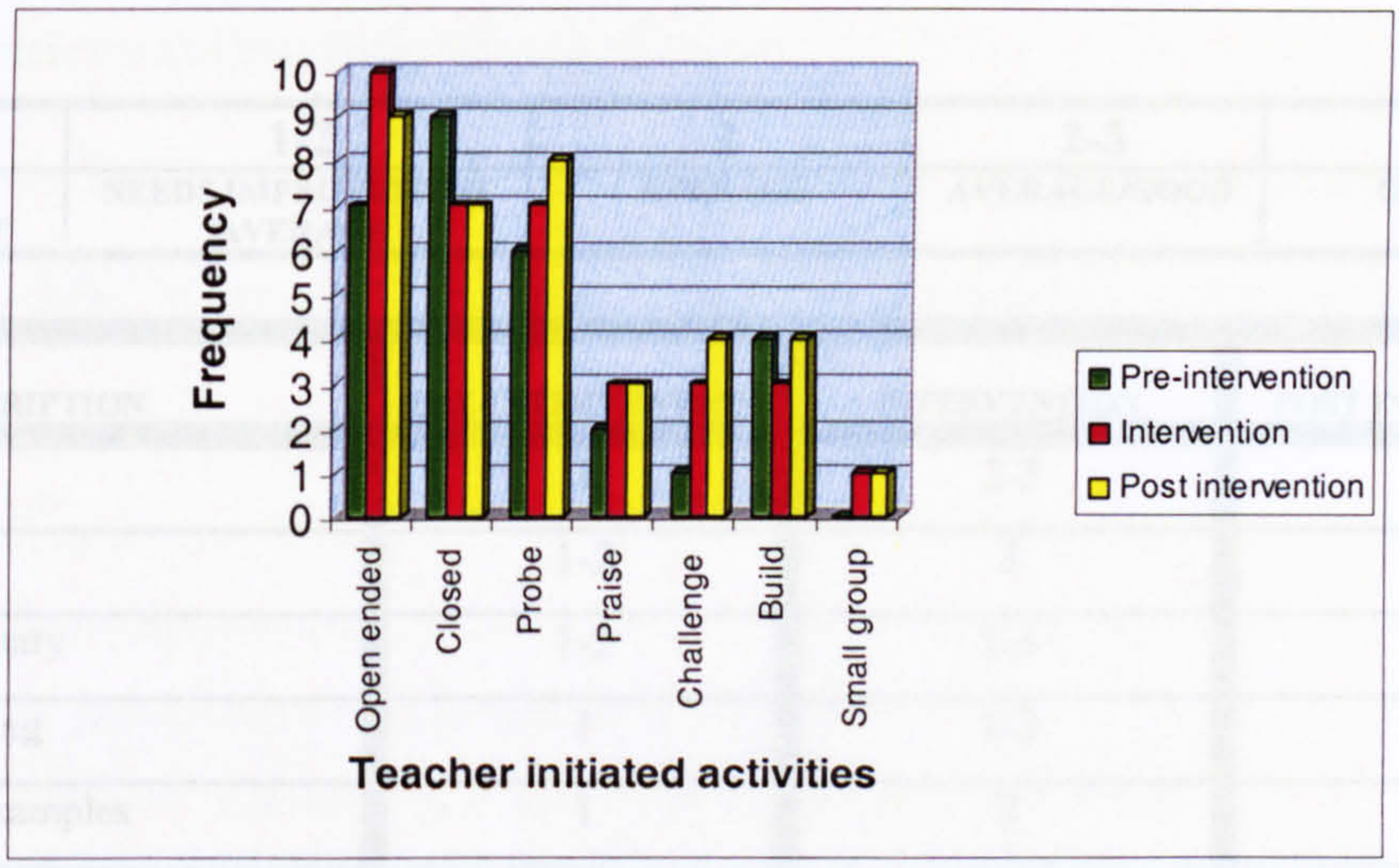

Figure 4.25: Structured observation results (Teacher 19CF, School C)

Like structured observation results, the descriptive data has revealed no definite pattern of change between intervention and post intervention phases (Table 4.32). However, there was a clear improvement from the pre-intervention to the post intervention period. The teacher 'needed improvement' in many aspects of lesson delivery during the pre intervention period but obtained an 'average' to 'good' rating during the post intervention period.

Key:

1	1-2	2	2-3	3
NEEDS IMPROVEMENT	**NEEDS IMPROVEMENT /AVERAGE**	**AVERAGE**	**AVERAGE/GOOD**	**GOOD**

DESCRIPTION	PRE-INTERVENTION	INTERVENTION	POST INTERVENTION
Use of materials	1	2-3	2-3
Introduction	1-2	3	2-3
Conclusion/summary	1-2	2-3	2
Transfer of learning	1	1-2	2-3
Use of realistic examples	1	2	2-3
Distribution of questions	2	1-2	2-3
Task explanation	2	1-2	1
Diverse problem-solving strategies	1	2	2

Table 4.32: Descriptive aspect of lesson observation (Teacher 19CF, School C)

4.19.1: Summary of lesson observations (School C)

The following conclusions could be made form lesson observations at **School C.**

- *Results from structured and descriptive lesson observations were for the most part consistent.*
- *All teachers experienced a degree of change from the pre-intervention to the post intervention phase.*
- *Some teachers experienced no change from the intervention to the post intervention phase.*
- *Some teachers experienced limited change from pre-intervention to intervention phase.*
- *Teachers were generally weak in most aspects of lesson delivery during the pre-intervention lesson observations.*
- *Most teachers demonstrated competence in task explanation and the distribution of questions among students during the pre-intervention lesson observations.*

4.20: Post intervention interviews *(School C)*

Teachers were interviewed towards the end of the research study in order to assess the degree of change in their belief and practices. Like pre-intervention interview data, the post intervention data was divided into four categories namely:

- *Beliefs on teaching*
- *Teaching practice*
- *Professionalism and professional growth*
- *Teachers' accounts of students' attitudes to their teaching*

❖ *Beliefs on teaching*

Teachers were asked whether there were changes in their beliefs on the teaching and learning of Mathematics and most indicated that there was a degree of change in beliefs. Teacher **10CF** claimed '*...there should be greater mix of methods where students are allowed to come up with their own solutions to problems'*. Teacher **11CF** suggested that a change in approach is needed but it might be too late at the secondary level since at the primary level students are used to a culture '*...where the teacher is in control and discussion is non-existent'*. Teachers **12CM** and **13CM** felt Mathematics should be taught by teaching children to think. According to Teacher **13CM**, '*...it takes a thinking teacher to teach thinking to students, so if the lesson allows teachers to think also, then everyone benefits'*.

Teacher **14CM** felt that teaching thinking assists in retention and therefore such methods are ideal for student learning. Teachers **15CF** and **16CF** attested to a change in view on challenge since they had recognised the benefits of challenge. Teacher **17CF** suggested that the child's ability to learn is influenced by the way in which a teacher approaches a topic and questions

students. Teachers **18CF** and **19CF** stressed the importance of making lessons practical. Teacher **18CF** claimed '*...when students see the relevance of what they are doing then they have a greater incentive to learn'.*

Teachers were then asked to give their perceptions on the use of whole class, direct instruction and most were of the view that whole class instruction was not the ideal teaching approach. However, all teachers admitted that this approach was used more frequently than any other. Teachers **11CF** and **14CM** claimed that the whole class teaching approach is better for the teacher than it is for the students since it makes life easier for the teacher in terms of direction and pace of lessons, and in terms of handling students' behaviour. However, according to Teacher **14CM,** '*...students don't get much from the approach in the long run*'. Teacher **11CF** admitted that the reason for their preference was the fact that '*...everyone wants to make life easier for themselves'.* Further she suggested that '*...the system is not ready...*' for such approach. She blamed the lack of preparedness on crowded classes, diverse student capabilities and on the fact that the syllabus had to be rushed.

Teacher **12CM** indicated that he always knew whole class teaching was not the best approach for student learning because '*...many students slip through the net...*' He claimed that there were no changes in his belief on whole class teaching since he was already aware of its limitations. Teacher **13CM** was also aware of the limitations of whole class direct instruction since he was convinced that '*...some topics are better taught in small groups'.* Teacher **15CF** added, whole class direct instruction was the best method '*...but it's the students who have to buck up'.* She argued that the approach is considered appropriate because '*...many students*

make it...' The teacher further suggested that the approach work '*...for brighter students since they can pick up the stuff quickly and move on*...' but the slower ones needed to be grouped differently. Teacher **17CF** was of the view that there must be a range of teaching approaches in the classroom and therefore whole class direct instruction should not be the only method. However, she suggested '*...in the current educational context, whole class teaching might be the most appropriate*'. Teacher **19CF** also supported the view that whole class instruction was most appropriate but she claimed that a lack of formal teacher training was partially responsible for her persistent use of the whole class teaching approach.

Teachers were then asked to give their perceptions on the use of small group activities as an instructional tool. Although teachers maintained their views of small group activity as being time consuming, they all appeared to have a change of perception in terms of the use of this approach in the classroom. Teacher **10CF** and **14CM** suggested that small group activity works but the teacher needs to be fully aware of the purpose for grouping students and must be in full control of students' behaviour. Teachers **11CF** and **19CF** were of the view that students enjoyed small group activity and in this regard, the approach was considered useful. According to Teachers **12CM** and **13CM**, the use of such approach is heavily dependent on students because on occasions, students may not want to work in groups. Teachers **15CF** and **18CF**, on the other hand, felt that the use of small group activity was heavily dependent on the setting. Teacher **15CF** claimed that the current educational setting is inappropriate for small group activity since '*...the syllabus has to be rushed*...' and classrooms are overcrowded. Teacher **16CF** considered teacher training as a major element in the success of small group

activity. She further indicated that '*...it takes time for students to get into the rhythm of small group activity*'.

Teachers were then asked whether there were changes in their perceptions on challenge and they all claimed that challenge is good for student learning. Teacher **10CF** considered challenge as being good for teachers as well, since '*...it forces the teacher to improve on practice.* Teachers **11CF** and **14CM** added that students should be allowed to look at things from different perspectives and try to solve problems using their own methods. Teachers **17CF** and **18CF** held the belief that in order for challenging lessons to work, the current examination system has to be changed to allow students to use various approaches to solve problems. Teacher **19CF** added '*...challenge is good but it is up to the teacher to use classroom challenge effectively*'.

❖ *Teaching practice*

Teachers were asked to describe their normal Mathematics lessons and most teachers claimed that their normal lessons still comprised mainly direct instruction. However, many teachers felt that there were differences due to the influence of thinking lessons. Most teachers claimed there was a change in their questioning approach. In addition, they indicated that they incorporated a greater degree of challenge in their lessons whatever strategy they used during teaching. Teachers also used group work to cater for differing abilities among students and there was greater use of praise during lessons. Most teachers indicated that they were less willing to give students answers to questions. Teachers' main reason for the continued use of

whole class direct instruction was the fact that they had to ensure that the syllabus was adequately covered.

Teachers were then asked to describe the thinking lessons and most felt that the lessons were practical and relevant to real life issues. They also felt that the lessons were challenging but time consuming. Teacher **10CF** claimed that it was difficult for students '*...since they had to begin thinking for themselves'*. She conceded that teaching thinking was '*...a learning exercise for both the teacher and students'*. Teacher **11CF** and **17CF** suggested that the lessons assisted students in seeing the relevance of Mathematics. It was interesting that Teacher **11CF** was of the view that although she was not particularly threatened by the approach, inexperienced teachers might not have felt the same way. The teacher believed her experience assisted in her coping with the challenge of teaching thinking because she was already confident in lesson delivery.

Teacher **12CM** considered thinking lessons as '*...a good way ...to try something different'*. Teacher **13CM** added, thinking lessons '*...helped students understand things on a broader level'*. Further, Teacher **14CM** believed the lessons brought a profound understanding to the topic '*...since the topics are taught on a deeper conceptual level'*. Teachers **15CF** and **16CF** considered thinking lessons as practical and hands-on approach to learning, whereas Teacher **19CF** considered thinking lessons as helping students realise the value of learning Mathematics.

❖ *Professionalism and professional growth*

Teachers were questioned on their opinions on reflection and although most teachers felt that reflection need not be in writing, they all held the perception that reflection is useful for professional growth. Most teachers claimed a change of opinion on reflection since they admitted that in the past, they gave little attention to the concept. According to Teacher **11CM**, '*...when you write on a report book, a child cannot add, you are indirectly writing, I did not teach that child to add ... and that is also reflecting on your performance in the classroom'.* The teacher considered the intervention programme as '*...a catalyst to reflection'.*

It was interesting that teacher **13CM** was of the opinion that '*...teachers should be given less a workload during teaching so that they can spend more time reflecting...*' According to the teacher,

> '*...instead of all the paper work ... they* [The Education Division] *should change these and make them opportunities for teachers to reflect so that the teacher could use his or her time doing things that will help make him or her a good teacher instead of just ...being aware of the need for accountability.*'

The teacher claimed that teachers cannot depend on formal training to improve practice '*...because there is hardly any given in most cases.*' All teachers indicated that although they collaborated in the past, there was an increased in collaboration during the research period. In addition, they claimed that greater attention was paid to teaching and learning issues during staff meetings.

❖ *Teachers' accounts of students' attitudes to their teaching*

Teachers were asked to give their perceptions on students' responses to the teaching of thinking. Most indicated that although there was not a dramatic change in students' responses, there were subtle differences. Teachers believed students' responses were of a higher level when they worked together in groups. Teachers were of the view that students' contribution and their level of thinking would depend on the individual capabilities as well as the nature of the lesson. They claimed that with interesting and practical lessons, students were more involved. Teachers generally agreed that weaker students were more willing to respond to questions and they showed greater interest in learning. They however, conceded that there was a tendency for students to deviate from the topic on some occasions. Teachers admitted that students rarely challenged others responses to questions and they mainly asked questions relating to clarification of instructions as opposed to those relating to lessons contents.

According to Teacher **11CF**, '*...thinking lessons cause students to think more and to understand with a deeper appreciation and a broader perspective'*. Teachers also admitted that students gave more thoughtful responses when they were allowed adequate thinking time. It was interesting that Teachers **12CM** and **16CF** were of the view that the teacher's questioning strategy determines the kind of responses that students give. Teacher **12CM** indicated that '*...with increased thinking time, students' responses were more sensible'*. Teacher **18CF** felt that students took too long to respond to questions since, '*...you* [the teacher] *ask a question and they* [the students] *take so long to get the answer that at times it is easier for you to just tell them the answer and move on'*.

4.20.1: Summary of post intervention interviews *(School C)*

The following represents a summary of post-intervention interview responses **(School C).**

MAJOR ISSUES	SUMMARY OF POST INTERVENTION INTERVIEW RESPONSES
Beliefs	There should be a greater mix of methods where students are allowed to come up with their own solutions. It takes a thinking teacher to teach thinking to students. When students see the relevance of the topic, they have a greater incentive to learn. Students don't get much from whole class direct instruction but this approach is simpler in terms of lesson delivery. In the current educational context, whole class direct instruction is most appropriate. The syllabus is often rushed due to time constraints. Reflection forces the teacher to improve on practice.
Practice	Whole class direct instruction was mainly used. During thinking lessons, students were more active. Lessons were practical and helped students understand concepts on a broader level. There was a change in questioning approach to allow more wait time. There was an increased use of challenge in all lessons. There was an increase in the degree of praise to students. There was a degree of reluctance in giving students information.
Professionalism and professional growth	Reflection is essential for professional growth. It is difficult to reflect on a daily basis due to lack of time. Thinking lessons served as a catalyst to reflection. Teachers should be given more time to reflect on practice. Staff collaboration was focussed on teaching and learning issues.
Teachers' accounts of students' attitudes to their teaching	The teacher's questioning approach may determine the nature of students' responses. Student participation would often depend on their degree of interest in the lesson. Weaker students were more willing to respond and showed greater interest in learning Mathematics. On occasions it was difficult to keep students focussed due to the nature of their responses.

Table 4.33: Summary of post-intervention interview responses (School C)

4.21: Mapping changes in teachers' beliefs and practices (School C)

Based on pre-intervention data, teachers were grouped into two major categories namely, *behaviourists* and *social constructivists*. Teachers within the *behaviourist* category were considered those with *traditional* classroom beliefs and practices. These include the promotion of rote learning, direct instruction and other methods where the teacher has a high level of control over students' learning. Teachers within the *social constructivists'* category were considered those who engaged in practices where students have a greater degree of control over their learning. Teachers were categorised on a matrix based on their perceptions and practices (Fig. 4.26).

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84
188
221

70
86
188
221

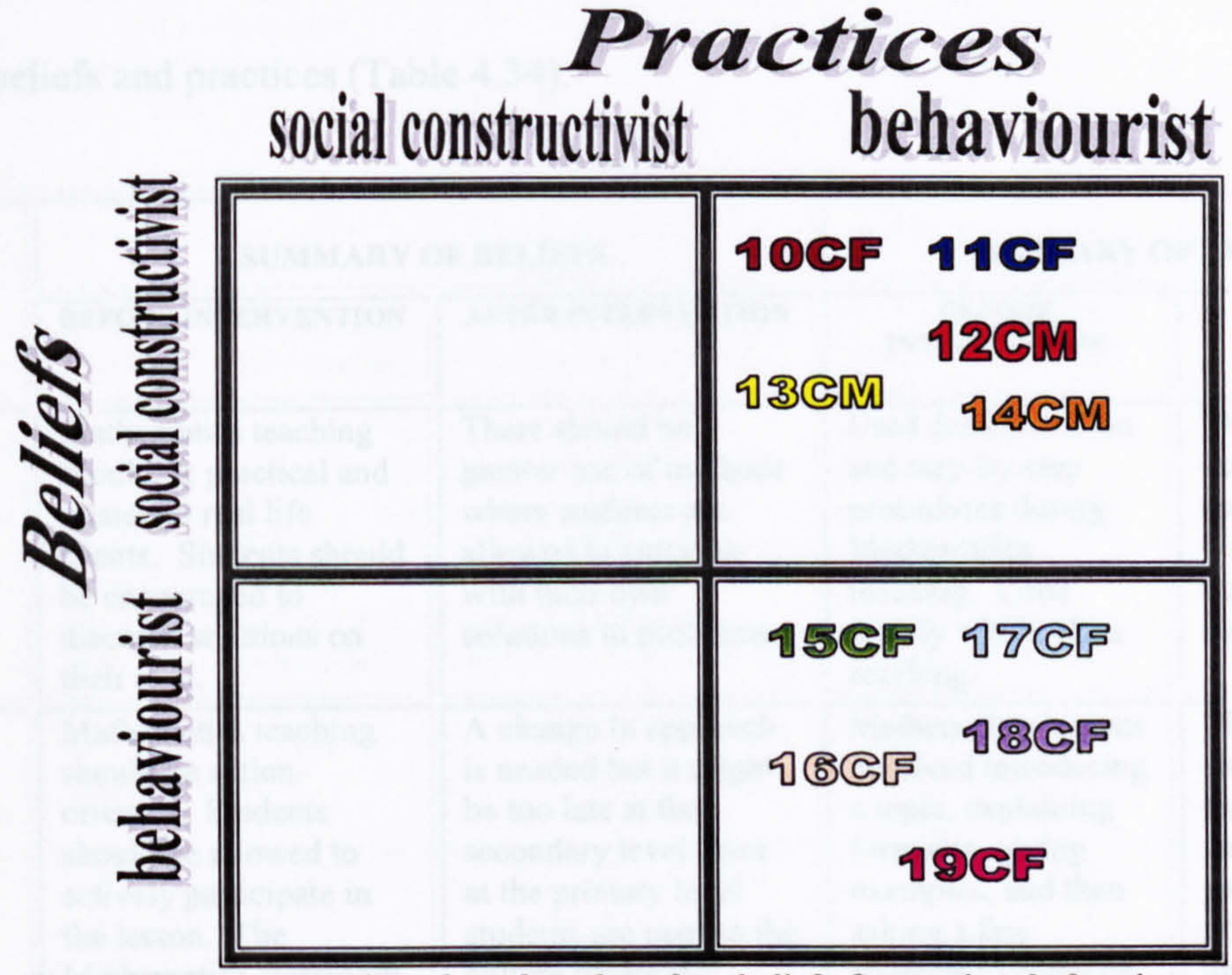

Fig. 4.26: Representation of teachers based on beliefs & practices before intervention (School C)

Key:

Social Constructivist: *Contemporary beliefs and practices*

Behaviourist: *Traditional beliefs and practices*

The above representation indicates that none of the teachers demonstrated social constructivist practices before the intervention programme. Teachers **10CF, 11CF, 12CM, 13CM** and **14CM,** who were mainly trained and experienced, held social constructivist beliefs but demonstrated behaviourists' practices. On the other hand, Teachers **15CF, 16CF, 17CF, 18CF** and **19CF,** who were mainly untrained and inexperienced, held behaviourists beliefs and demonstrated behaviourists' practices.

At the end of the intervention period, an attempt was made to represent teachers on a chart based on a summary of the potential changes in beliefs and practices. This was done through a comparison of pre and post intervention data to establish the approximate degree of change in teacher beliefs and practices (Table 4.34).

TEACHER CODE & STATUS	SUMMARY OF BELIEFS		SUMMARY OF PRACTICES	
	BEFORE INTERVENTION	AFTER INTERVENTION	BEFORE INTERVENTION	AFTER INTERVENTION
10CF Trained	Mathematics teaching should be practical and related to real life events. Students should be encouraged to discover solutions on their own.	There should be greater use of methods where students are allowed to come up with their own solutions to problems.	Used demonstration and step-by-step procedures during Mathematics teaching. Used mainly whole class teaching.	There was a greater use of diverse approaches. There was a change in the questioning approach used.
11CF Trained	Mathematics teaching should be action-oriented. Students should be allowed to actively participate in the lesson. The Mathematics classroom should be like a little laboratory where students discover things and feel a sense of belonging.	A change in approach is needed but it might be too late at the secondary level since at the primary level students are used to the culture where the teacher is in control and discussion is non-existent.	Mathematics lessons involved introducing a topic, explaining formulas, giving examples, and then asking a few students to come up on the board to try them. Mainly whole class direct instruction was used.	There was a slight change in the teaching approach used. There was greater use of effective questioning approaches, praise to students, small group activity and challenge during lessons.

12CM Trained	Mathematics lessons should be exciting and students should feel relaxed in the classroom. Lesson contents should be related to real-life examples.	Mathematics should be taught by teaching children to think.	Demonstrated methods of answering questions and allowed students to practice with other questions. Mainly used whole class teaching during lessons.	Used whole class teaching on occasions but used group work to cater for differing abilities among students. There was greater use of praise and challenge during lessons.
13CM Untrained	Mathematics learning should be enjoyable. Students should be shown that they are doing the subject, not only for the knowledge but also for the fun of it.	Lessons should encourage students to think but it takes a thinking teacher to teach thinking to students.	Modelled solving problems using step-by-step procedures and allowed students to practice solving these problems. Used whole class direct instruction.	Greater use of mixed approaches. There was still a desire to give students answers to questions.
14CM Untrained	Mathematics teaching should be down-to-earth, fun and exciting. Students should be allowed to think and to practice methods of solving problems.	Teaching thinking assists in retention and therefore such methods are ideal for student learning.	Introduce the topic by showing students the appropriate ways of solving problems and then allowing them to practice on their own until they can answer the questions.	Mainly whole group instruction. Also used other approaches like group work. There was change in questioning methods utilised.
15CF Untrained	In the Mathematics classroom students should be given formulas and allowed to practice these formulas in order to get questions correct.	It is important to challenge students in the classroom. Group work can be effective if it is well managed.	Used whole class teaching to model the ways to work out problems and allow students to practice these formulas.	Used whole group teaching on most occasions but on some occasions used group activities to cater for different abilities in the classroom.
16CF Untrained	During Mathematics teaching the teacher should demonstrate and then allow students to practice solving the problems using the formulas given.	In the Mathematics classroom students must be shown different ways of doing things.	Used mainly whole class teaching to explain ways of solving problems and then gave students practice in solving these problems.	During normal lessons whole group teaching was used. However, there was grouping particularly during thinking lessons.

17CF Untrained	Mathematics teaching is all about giving students practice in whole groups. During small group activities, students don't work as hard as they should and they wait for one person within the group to do all the hard work.	The teacher should make Mathematics lessons fun. The way in which a teacher approaches a topic and questions students affects students' ability to learn.	Used whole class instruction to demonstrate methods of solving problems and allowed students to practice exercises using the methods explained.	Thinking lessons involved group work and different approaches but there was mainly whole class teaching for normal lessons.
18CF Untrained	The teacher should allow students opportunities for practice and to solve problems.	Mathematics lessons should be practical since students have a greater incentive to learn when they see the relevance of what they are doing.	Gave students examples and then allowed then to practice formulas. Identified weaker students and paired them with brighter ones.	Students were shown different ways of solving problems but they were mainly taught within a whole class arrangement.
19CF Untrained	Mathematics teaching should be about allowing students to do exercises. Students would only do well in Mathematics if they practice using the exercises in their text.	Lessons should be practical and students should be given opportunities to participate.	Students were shown the most effective ways of solving problems using the fastest formulas. Pitched the lesson at the average group with the hopes that every child will get something from the lesson.	Mainly used whole group instruction but efforts were made to allow students more opportunities to solve problems themselves, without the teacher's assistance.

Table 4.34: Summary of pre and post intervention beliefs and practices (School C)

Fig 4.27 serves as a guide to the ***approximate*** degree of change in the beliefs and practices of the teachers of **School C**.

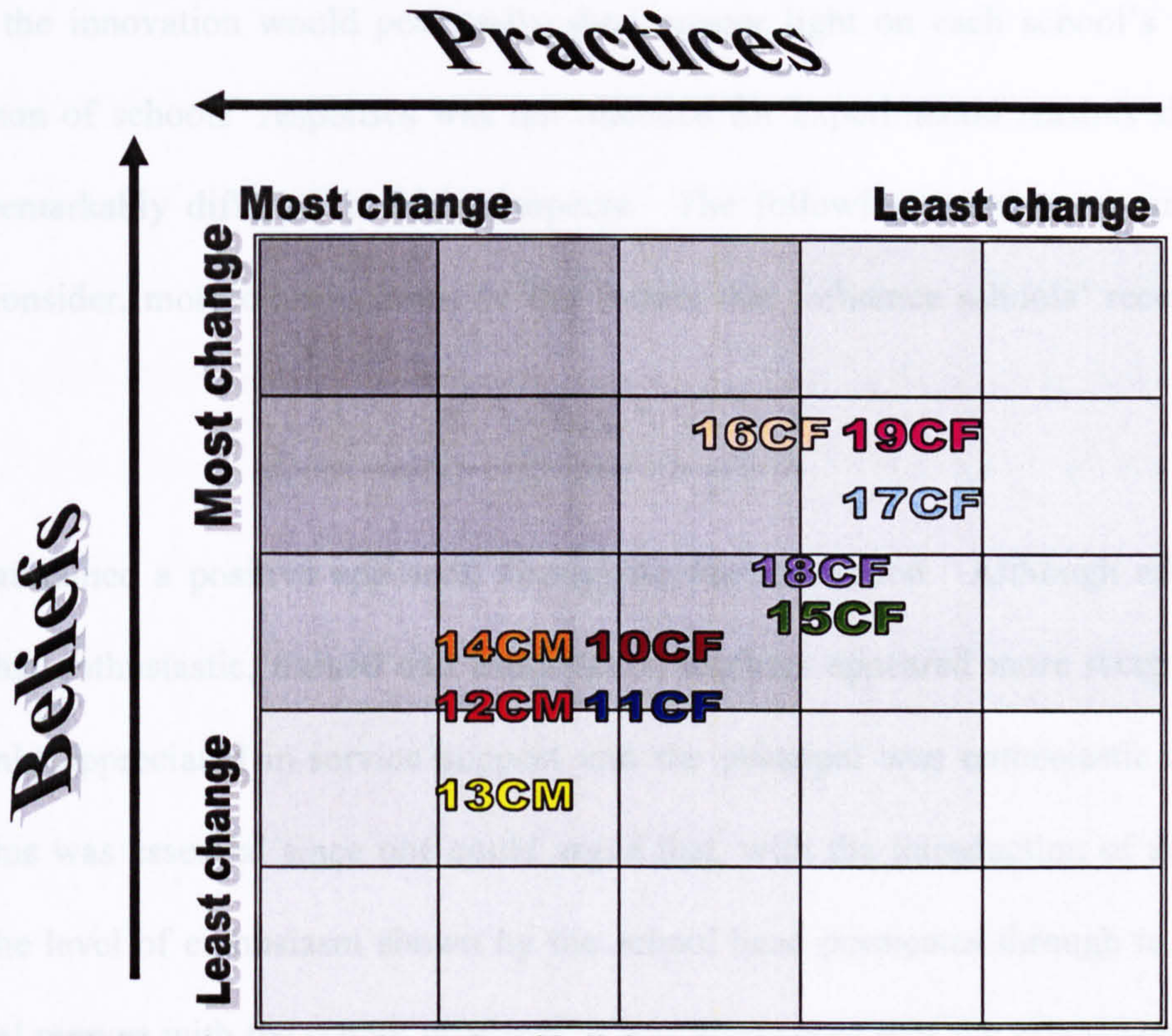

Fig. 4.27: Mapping changes in teachers' beliefs and practices after intervention (School C)

Based on an analysis of research data, there was marginal change in the beliefs and practices of the teachers of **School C**. Teachers **15CF**, **16CF**, **17CF**, **18CF** and **19CF**, who were mainly untrained and inexperienced, demonstrated a greater degree of change in beliefs but change in their practice was not as obvious. On the other hand, Teachers **10CF, 11CF, 12CM 13CM** and **14CM,** who were mainly experienced, did not demonstrate much change in beliefs but there was greater change in practice than their untrained and inexperienced counterparts.

4.22: A comparison of schools

Based on the results obtained from individual schools, it was felt that a comparison of schools' responses to the innovation would potentially shed greater light on each school's response. The comparison of schools' responses was not intended for experimental reasons since each school was remarkably different in many respects. The following comparison was simply intended to consider, more closely, some of the factors that influence schools' receptivity to change.

School A maintained a positive approach throughout the innovation. Although all teachers were somewhat enthusiastic, trained and experienced teachers appeared more receptive. All teachers openly appreciated in-service support and the principal was enthusiastic about the initiative. This was essential since one could argue that, with the introduction of any school innovation, the level of enthusiasm shown by the school head permeates through to the staff. Upon informal rapport with the school principal, it was discovered that she eagerly encouraged external support and the professional development of her staff. Hence, many teachers on staff appeared to share this enthusiasm. The staff's enthusiasm was also reflected in workshop evaluations that were held after various training workshops (*Appendix Q*).

School M was also positive about the innovation but did not always share the degree of enthusiasm experienced at **School A.** The teachers were often caught up with other school initiatives as well as routine school duties. Informal rapport with the principal revealed that, although he was highly enthusiastic about the intervention, there were many staffing problems that overshadowed his enthusiasm. As seen with **School A,** the evaluation of teacher training

sessions were positive (*Appendix Q*) but teachers were still sceptical of the innovation since they felt that it might have been just another of many education initiatives in recent months.

School C was generally enthusiastic about the innovation particularly during its early and middle stages. The level of teacher enthusiasm varied greatly from one teacher to the next and like **School A**, the experienced teachers were more receptive than their untrained counterparts. The principal visibly demonstrated her support. During informal rapport it was discovered that her leadership style was one where middle management had much autonomy. Hence, after she approved an initiative, she would leave it to the Departmental Heads to ensure that it succeeds. In addition, the Head of the Mathematics Department had a high degree of influence on the Mathematics staff. As seen with the other schools, these teachers also held a positive perception of the teacher training workshops (*Appendix Q*).

4.23: Conclusions

Based on the data gathered from the schools under study, the following conclusions could be made:

- *School status and availability of human and physical resources did not influence teachers' perceptions and performance.*

- *School management played a major role in terms of teachers' receptivity to the innovation but not necessarily in terms of sustained teacher development*

- *Teachers gradually began to revert to their traditional practices after a brief period of change.*

- *Teachers appeared to have an external locus of control since trained teachers blamed the Education System (curriculum framework, assessment system, unavailability of resources, etc) for their limitations. Untrained teachers, on the other hand, blamed lack of training for their limitations.*

- *Teacher experience and training was not a deterrent to change since there was a greater degree of change in the practices of formally trained and experienced teachers as compared with untrained and inexperienced teachers.*

- *Teachers appeared not to address issues relating to lesson delivery during reflection. Although they were given guidelines for self-reflection, which entailed many aspects of lesson delivery, teacher reflection focussed predominantly on issues relating to student performance and lesson content as opposed to pedagogy.*

- *Teachers would only subscribe to an innovation in the long term if they believe it would not add to existing pressures, even if there was a potential for students to benefit from the innovation.*

The findings revealed that irrespective of school status and the availability of human and financial resources, there was no obvious difference between schools in terms of teachers' responses to the innovation. As mentioned earlier, in all schools under study, there appeared a lack of sustained growth after the period of active intervention. In addition, there were identical levels of professional growth among teachers, and in some cases there was greater

variation among individual teachers within the same school, than there was among teachers of different schools.

A point of interest was teachers' *locus of control* based on their responses during various phases of the intervention. Although all teachers recognised the value of a progressive approach to teaching, both trained and untrained teachers cited reasons for a lack of sustained change in practice. It was clear that all teachers attempted to identify a factor that was beyond their immediate control.

Another interesting development was the fact that experienced teachers, in all the schools under study, appeared to be even more receptive, and in many instances demonstrated a greater degree of change in practice than their less experienced counterparts. Experienced teachers also appeared to share progressivists' perceptions of teaching and learning even before the active intervention phase. One may conclude that these teachers might have responded in such a manner with the hopes of pleasing the researcher. However, the fact that the teachers held such perceptions means that they were aware of progressivists' approaches.

The fact that experienced teachers demonstrated a greater degree of change in practice was contrary to popular beliefs, since it is often assumed that '*experience*' breeds complacency and subsequent *resistance* to change. The latter reiterates the argument that individuals respond to change based on personal attributes and as mentioned earlier, the ***self*** is a crucial factor in determining individual growth and receptivity to change. The factors that teachers perceived as inhibitors to change could be categorised on two levels. These included school related factors and factors beyond the school's immediate control. One could therefore argue that in

order to encourage sustained teacher change in the Dominican context, proposed innovations need to consider the above factors.

CHAPTER 5

DISCUSSION AND IMPLICATIONS

5.0: Purpose of the study

The research study involved the implementation of a cognitive intervention programme at three secondary schools in Dominica in order to determine:

- *The extent to which it contributed to the professional development of teachers in terms of their ability to reflect on practice.*
- *The degree of change (if any) in teachers' beliefs and/or practices as a result of the innovation.*

5.1: Research findings

The following conclusions were made based on the results obtained from the schools under study:

- *School status and availability of human and financial resources did not influence teacher perception and performance.*
- *School management played a major role in terms of teachers' receptivity to the innovation but not necessarily in terms of sustained teacher development.*
- *Teachers gradually began to revert to traditional practices after a brief period of change.*

- *Teachers appeared to have an external locus of control on the question of sustained change in practice. Trained teachers mainly blamed the Education System (curriculum framework, assessment system, unavailability of resources, etc) for their limitations. Untrained teachers, on the other hand, mainly blamed lack of training for their limitations.*

- *Teacher experience and training was not a deterrent to change since there was a greater degree of change in the practices of formally trained and experienced teachers as compared with untrained and inexperienced teachers.*

- *Teachers appeared not to address issues relating to lesson delivery during reflection. Although they were given guidelines for self-reflection, which entailed many aspects of lesson delivery, teacher reflection focussed predominantly on issues relating to student performance and lesson content as opposed to pedagogy.*

- *Teachers would only subscribe to an innovation in the long term if they believed it would not add to existing pressures, even if there was a potential for students to benefit from the innovation.*

5.2: The importance of the *self* in teacher development and change

The study revealed that irrespective of various degrees of receptivity among schools, there was no obvious difference between schools in terms of teachers' responses to the innovation. In addition, school status and the degree of human and financial resources did not influence

teachers' responses. There were identical levels of professional growth among the schools, and in many cases, there was greater variation among individual teachers within the same school, than there was among schools. This reiterates previous arguments that every teacher is different and hence, the importance of the *self* in the decision-making. Fetterman (1989) argued that people act based on their individual perceptions, and those actions may have real consequences. Nias (1989) added, since no two people have the same life experiences, we learn to see the world and ourselves as part of it in different ways.

According to Hargreaves (1992), every teacher brings to the exercise of his/her profession a unique personality and set of attitudes, skills and preferences. Hence, no matter how pervasive particular aspects of a shared social occupational culture might be or how well individuals are socialised into it, the attitudes and actions of each teacher are rooted in their own ways of perceiving the world. One can effectively conclude that the *self* is a crucial factor in determining individual growth and receptivity to educational change. The above viewpoint was supported by Teacher **11CF** (a teacher with over ten years experience) in her contention that the degree of receptivity to an innovation '*...all depends on the individual...*'

5.3: The dilemma of teacher experience in the need for change

Many teachers held traditional belief systems prior to the research study. However, this was not particular surprising since most secondary teachers in the Dominican context enter the classroom without prior teacher training and are unaware of the range of instructional approaches available to teachers. Another interesting observation was that experienced teachers, in the schools under study, appeared more receptive and in many instances

demonstrated a greater degree of change in practice than their less experienced counterparts. This was contrary to popular beliefs, since it is often assumed that '*experience*' breeds complacency and subsequent *resistance* to change. Such arguments include the assertion of Miller (1967) that the idea of experience and the false sense of security that it provides assist in inhibiting innovation. Sikes (1992:45) added that change is often resisted by older, more experienced teachers who point to the way that educational fashions come and go in their claim that they *'have seen it all before'*.

However, one might view experience in a different light with regards to change in classroom practice. With experience comes a degree of confidence in one's job and such confidence is essential to facilitating the change process. According to Calderhead (1996:22), experienced teachers often have a much more sophisticated understanding of their practice since they appear to have access to a wide range of knowledge that can be readily accessed when dealing with classroom situations. Calderhead claimed that studies of experience and novice teachers suggest that there is an enormous diversity of knowledge that experience teachers possess. In addition, acquiring appropriate professional knowledge is often a difficult and time-consuming process for novice teachers. The latter suggestion was supported by Teacher **11CF** (an experienced teacher) in her contention,

> '*...with experience you learn to listen to others views, put forward your own, look at the similarities and differences between them and see where you can agree. I don't believe experience teachers resist change. I think that experience brings flexibility...it brings strength and it brings openness. You know that you have confidence and you see the child not as an inferior person but someone who comes to the classroom with something useful...*'

It was not surprising that inexperienced teachers in the research study demonstrated the least change in practice, since their lack of confidence in teaching might have impeded their response to the initiative. Many inexperienced teachers also supported the view that confidence affects receptivity to change. Teacher **4AF** (an inexperienced teacher) indicated that she '*...survives teaching on a day-to-day basis and gets more confident as time goes by...*' The teacher further added that '*...dealing with students on a daily basis is a workload and that leaves time for little else.*' The above arguments might suggest that receptivity to change depends more on personal traits and individual convictions than on the qualities such as experience and training.

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5.4: Disparity between teachers' beliefs and practices

Teachers in the schools under study did not always practice what they believed, since some held progressive views of teaching and learning but adopted traditional practices. According to LeCompte and Goetz (1984:42), one problem that researchers might encounter is that participants' reports of their activities and beliefs are often widely discrepant from their observed behaviour. Prubhu (1987:106) suggested that teachers might disassociate perceptions from practice, operating with the perceptions in contexts that are seen to be relevant, such as professional discussion, but operating without it in the classroom. Fullan (1991:40) added that it is possible to change at the surface by endorsing certain goals, using specific materials and even imitating the behaviour, without specifically understanding the principles and rationale for change. Further, he argued that with reference to beliefs, it is possible to value and even be articulate about goals of the change without understanding their implications for practice.

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Even after a period of active intervention, in instances where teachers used progressive approaches there was a lack of sustained change due to what they considered as 'constraints posed by the educational context'. According to Leat (1999:387), along with most other curriculum innovations, thinking skills programmes usually fail to make a lasting impact or become established in the school systems, despite promising evidence of their effects. Hence, Leat believed curriculum development needs to give much closer attention to teacher development if it is to be successful.

As stated by Hargreaves (1994:17), before sustained implementation, teachers '*tinker*' with an idea to see how well it fits their personal style and conditions of their particular classroom. This was clearly highlighted in the views of Teacher **8MF** that progressive approaches work but '*...it takes time, patience, material and expertise...features that are hardly present in the current educational environment...*' Teacher **7MF** added that such approach '*...may be better for students but certainly harder for the teacher in that you have to go out of your way to get stuff to deliver your lesson*'. According to Teacher **9MM**, '*...it is difficult to have such lessons all the time since one will not finish the syllabus because it takes too much time and it is stressful for the teacher to do these lessons on a day-to-day basis'.* The perceptions of these teachers were not particularly surprising since it is widely agreed that sustained change in practice takes time.

The most common reason, cited by teachers, for the continued use of traditional approaches, were problems with the education system such as lack of time for completing the curriculum. Many teachers appeared to have a combination of traditional approaches with some elements

of a progressive approach. Cohen and Ball (1990:334) suggested that teachers often assimilate new information to traditional beliefs about learning. They referred to the latter phenomenon as *'new wine poured in old bottles'*. Garrett and Bowles (1997) noted that although there may be changes in teachers' beliefs after an innovation, it does not necessarily mean that changes in practice may follow since these may depend on the context within which teachers are working as much as their improved knowledge.

It should also be noted that teachers in Dominica might have encountered difficulty in adopting the new approach since it represents a total change in their teaching tradition. According to Fullan (1991), change in teaching approach presents great difficulty if new skills are to be acquired and new ways of conducting instructional activities established. Although most teachers might have had a change in belief, it could also have meant that the apparent change might have been pretence with the hopes of pleasing the researcher. Fullan (1991) asserted that changes in belief are even more difficult since they challenge core values held by individuals regarding the purpose of education.

Lacey (1977:72) identified three reactions that teachers may display in response to perceived innovations. Firstly, he identified strategic compliance, in which the individual complies with the authority figures definition of the situation and the constraints of the situation but retains private reservations about them. The second reaction is that of internalised adjustment where teachers comply with the constraints and believe that the constraints of the situation are the best. Finally, there is strategic redefinition of the situation, which implies that change is brought about by individuals who do not possess the formal power to do so. In this study,

although some teachers were clearly at the internalised adjustment phase, it might have meant that many remained at the strategic compliance level.

5.5: The impact of school culture on teacher change in Dominica

The teachers under study might experience difficulty adjusting to progressive approaches due to an over-reliance on a traditional culture of teaching and learning. The unavailability of pre-service teacher training in Dominica might have meant that many teachers were only familiar with traditional methods of teaching. These methods were either acquired from their experiences with the learning process or from their more experienced, often untrained peers. Lortie (1975) highlighted an apprenticeship of observation, in which the experiences of being taught as a pupil, internalises a model of teaching.

Brown and Mc Intyre (1993:5) developed a concept of Normal Desirable State (NDS), which constitutes the criteria by which teachers decide whether lessons have gone well. Hence, a lesson could be considered satisfactory as long as pupils acted in a way that the teachers perceive as desirable. According to Leat (1999:393), to introduce thinking skills in the classroom is to risk the activity flow, upset this normal desirable state and jeopardise chance of order. Hence, teacher would naturally be reluctant to subscribe to any activity which would upset the status quo. As stated by House (1979:9), the most remarkable feature of the educational system is its capacity for continuity and stability in the face of efforts at change. Eraut (1994) added that there appears to be a hear stone in classroom interaction that is incredibly enduring and makes some forms of educational change extremely problematic.

School culture had a pivotal role to play in teacher change in the Dominican context. The fact that some teachers were seasoned in a traditional culture meant that they maintained components of this culture. It is often argued that culture is difficult to change. Hargreaves (1994:12) indicated that two of the main barriers to change were the professional culture of teachers and the nature of school and classroom organisation. He believed professional and institutional structures and cultures are resilient and as such they withstand many an assault. They also have powerful capacities to maintain and reproduce themselves despite surface changes. According to Sikes (1992), the concept of *cultures of teaching* is crucial to any consideration of change because it is through cultures that change is mediated, interpreted and realised. Dalin et al. (1993) added that culture plays a significant role as a determinant of change and as such we should know what parts of the school culture might hinder meaningful and desirable changes. As stated by Deal and Kennedy (1983b), when culture works against you, it is nearly impossible to get anything done (pg. 4).

In order for educational innovations to be sustained, then teachers' need to maintain a high degree of receptivity and open-mindedness. According to Bahar et al. (1996), successful innovation relies, in part, on the extent that the proposed innovation is compatible with teachers' beliefs relating to appropriate programmes of instruction as well as the priority given by teachers to the change initiative. Bahar et al. (1996:7) identified the following factors as essential to the success of any curriculum innovation.

- *Teachers' beliefs in the need for such change.*
- *Teachers' ability and willingness to modify their practice.*
- *An administration and school that supports such innovation.*
- *Instructional guidance.*
- *Ensuring that the teaching staff's effort is consistent with the mission of the innovation.*

Gross et al. (1971) added that the degree to which any innovation is successfully implemented would depend on the following five conditions:

- *A clear understanding of the innovation*
- *Members who are capable of its implementation*
- *Availability of materials and other resources*
- *Organisational arrangements that are compatible with the innovation*
- *Staff who are willing to sacrifice time and effort towards its success*

In this study all of the above elements were present and yet sustained change on the part of teachers could not be realised. Hence, based on the Dominican context, the factors suggested by Bahar et al. (1996) and Gross et al. (1971) might be considered slightly inadequate since the following factors appeared missing:

- *An education system that facilitates the change process*
- *Assurance that the proposed change will not dramatically increase teachers' workload*
- *A statement of whose interest the innovation is designed to serve*
- *A school structure capable of embracing the innovation with relative ease.*

Fullan (1991:68) identified several factors affecting the successful implementation of educational change. He grouped these factors into three broad categories namely, *characteristics of change*, *local characteristics* and *external factors*. Under characteristics of change he identified need, clarity, complexity and quality or practicality of change. With respect to local characteristics he considered the education district, community, principal and teachers. Finally, under external factors he identified the government and other agencies. It would appear that deterrents to sustained change in this study were mainly related to 'local characteristics' and 'external factors'. Based on the results of the study, one could identify a number of factors influencing the successful development of thinking skills in the Dominican

context. Some of these factors could be represented as a SWOT analysis so as to determine the complementary and opposing factors (Fig. 5.0).

STRENGTHS

Teachers' recognition of the limitations posed by traditional systems

School heads and middle management who are receptive to the change process

An education system committed to change

A fair degree of dedication among teachers in their commitment to student learning

WEAKNESSES

Limited proportion of formally trained teachers

Traditional curriculum and assessment frameworks

Lack of adequate teaching resources for schools

School plant conducive to traditional teaching methods

OPPORTUNITIES

An education system in transition

Teachers and students with easily available access to information

Teachers who are eager to be formally trained

A high proportion of young teachers

THREATS

Financial constrains that might impede education initiatives

A large proportion of policy makers with traditional conceptions of education

Communities that still maintain traditional conceptions of the role of schools and teachers in the learning process

Fig. 5.0: A SWOT analysis depicting the factors influencing the teaching of thinking in Dominica

5.6: Environmental influences on teachers' practices

Teachers identified various factors that influenced their practice. However, one of the major factors was time constraint. The issue of time was a crucial factor in determining teachers' use of progressive approaches since most teachers felt that the pressures to complete the curriculum influenced the teaching approach utilised. This argument was succinctly put forward by Teacher **6AF** in her view that '*...everything is about completing the curriculum and covering the contents for examinations so the teacher has to use the fastest way.*' The fact that the school syllabus had to be completed within a specified time was of interest since it meant this was an essential goal for teachers.

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The issue of context was also essential since many teachers felt that the educational context was not supportive of the approach. Bennett et al. (1997) suggested that context acts in various ways that either enable or constrain the enactment of teacher theories in practice. They believed that the extent to which teachers fulfil their ideal teaching orientations will depend on factors at classroom, school, local and national levels. According to Bennett et al., whether and how practice changes will depend on the extent to which teachers are able or willing to reflect on links between intentions and practice. The above arguments appear in line with research results because even after teachers recognised the advantages of progressive approaches, they still utilised traditional approaches to a great extent.

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Doyle (1979:31) argued that environmental demands posed by classroom arrangements establish limits on the range of teacher behaviours that can be successful in particular settings and that successful teachers must learn a set of coping strategies appropriate to that setting.

According to Zeichner et al. (1987:54), one of the most influential factors in determining the level of institutional constraints on teachers was technical control exerted through the timing of instruction, the curriculum, curricular materials and the architecture of the school. Bennett (1976), in his study of teaching styles and pupils' progress, discovered that teachers opted for traditional rather than progressive instructional approaches due to external constraints that impinged on classroom practice. Factors such as curriculum frameworks, assessment procedures, management styles, school ethos, time constraints, availability of teaching materials, school physical settings, government policies, peer pressure and an over-reliance on routine approaches may all contribute to potential disparities between teachers' beliefs and their subsequent classroom practices.

5.7: Teachers' locus of control

Based on the responses given for lack of sustained implementation on the part of teachers, it appeared that many teachers' had an external *locus of control*. Teachers generally recognised the value of a different approach to teaching, however both trained and untrained teachers cited reasons for their inability to sustain a change of practice. In most instances trained teachers blamed the Education System while untrained teachers blamed a lack of formal teacher training. According to Teacher **11CF**, '*...the system is not ready for such approach*'. Hence, it was clear that teachers attempted to identify factors that were beyond their immediate control.

As stated by Higgins and Leat (2001), who is in control of teachers' development is a crucial issue and as such an approach to professional development that ignores this issue is missing a vital component. Rotter (1966) identified two particular control dynamics within

organisational behaviour. The first identified individuals who feel very much in control of themselves as agents of their own destinies as *internals*. In this respect, the locus of control is within themselves. Secondly, there are those who feel that they have very little control over what happens to them and are referred to as *externals* since their locus of control is perceived as being external to themselves. In this study, teachers clearly felt that they had minimal control over the approach that they utilised and therefore sustained change would not occur with such beliefs.

5.8: The trade off between the innovation and its benefits

Based on teachers' responses to the innovation in the Dominican context, it was deduced that teachers might not necessarily change practice in the long run if the workload involved in the change process was too great or appeared incompatible with the educational structure, irrespective of the potential benefits to students. According to Nicholls (1983), innovations may require teachers to give up practices in which they feel secure and to adopt new practices in which they feel less secure. Nicholls suggested that the extra workload that innovations bring should not be overlooked since some teachers who are less enthusiastic may display a high level of reluctance. According to Day (1986b) few people will readily abandon a relatively stable constant world over which they have at least some control unless they can see real advantages from the endeavour. Leat (1999) added that when thinking skills programmes run into problems, socialising forces will encourage teachers to return to a default mode.

Leat identified the following five factors which determine teachers' responses to thinking skills programmes (pg. 390-398):

- *Socialisation*
- *Craft knowledge and expert/novice*
- *Pedagogical content knowledge*
- *Images of teaching*
- *Teaching and the emotions*

Fullan (1991) suggested that teachers use the following criteria to assess change before acceptance or rejection (pg. 127-28):

- *Does the change address a need? Will students be better off?*
- *How clear is the change in terms of teachers' roles?*
- *Is there evidence that it has worked elsewhere?*
- *How well will it affect the teachers' personally in terms of time, energy, new skills and interference with existing priorities?*
- *How rewarding will the experience be in terms of interacting with peers or others?*

5.9: The impact of the innovation on students' learning

From teachers' perceptions of students' responses to the teaching of thinking, it was concluded that there was a degree of student growth during the innovation but not as much as might have been expected. In addition, change in the pattern of students' responses were only realised after a period of prolonged intervention. This was not surprising since profound change in students' attitude to learning was not expected as an immediate and short-term outcome of the intervention.

The limited degree of change in students' learning could also have been attributed to the fact that in many cases teachers only partially used the thinking skills strategy. Askew et al. (1997) claimed that teachers may subscribe to a particular teaching strategy but if they are not

convinced of, and do not understand the pedagogical rationale underpinning their actions, there will be limited impact on students' learning. Teachers also felt that students' responses varied based on individual students and the lesson contents. Hence, students are invariably different and this reiterates the need for designing lessons in a manner that captures these differences.

5.9.1: Classroom interaction in the Dominican context

Teachers generally felt that there was greater student collaboration where small group activity was actively used and where the teacher had a clear objective in mind. In addition, they believed weaker students were more inclined to respond and demonstrated greater participation when lessons involved a high degree of collaboration. Adey et al. (1995) asserted that the single most important classroom management skill responsible for the development of students' thinking is the engineering of situations where there is maximum use of collaborative work.

Jones *et al.* (1996) claimed that in new learning students often grapple with partially formed ideas and try out half-formed solutions to problems. They believed that for many students this can be a lonely and frightening experience and collaborative work often helps them gain greater confidence and feel more comfortable when taking risks. Biott and Easen (1996:215) added that it is necessary to create favourable classroom conditions so that children value working together and have opportunities to give and experience help and support. Nesher (1998) believed conversations among students where they discuss among themselves valid arguments, forms the core of teaching and learning. Streefland (1998) further claimed that

creating a classroom climate that encourages broad participation provokes reflections in students' and gives them an opportunity to compare, agree and refute.

According to Andrews *et al.* (1991), teachers need to provide students with opportunities to discuss their viewpoints and students must feel free to question, explore and expose their own knowledge limitations or misconceptions without fear of ridicule. They suggest that many students have difficulties with learning because they tend to be passive rather than active learners. Such quality is often created and nurtured by traditional education systems that focus solely on instruction, individual activities and the acquisition of knowledge, as is the case in the Dominican context. Edwards and Westgate (1994) considered the usual teaching pattern in the traditional context as that of *question-answer-comment*, where the teacher makes the initial and final statements.

Hargie (1978) added to the latter argument in his suggestion that teachers control classroom talk with pupils only providing short, direct and uncomplicated responses. As stated by Jones and Wakefield (1998:66), when students undertake collaborative work they gain greater confidence and feel more empowered to take risks, which lead to greater learning. It is essential to encourage students to discuss ideas in the classroom. From a cognitivist viewpoint, as students begin to communicate ideas, they learn to clarify, consolidate and refine their thinking (NTCB 1989). Hence, communication in this sense is relevant for its effects on the process of learning and on the quality of the resulting knowledge. According to Lave and Wenger (1991), from an interactionist or social constructivist perspective, the idea of learning

through interaction is a natural by-product of that of learning as an initiation into a community of practice.

5.9.2: The effectiveness of small group activity

The study revealed that teachers were initially reluctant to utilise small group activity as an instructional approach since many teachers felt that this was a time-consuming exercise in terms of classroom organisation and in entertaining students' responses. In addition, since teachers could not readily assess the learning of individual students, they felt that the method was not worth the effort. During the initial stages of the study, teachers also felt that small group activity created problems with class management. Further, the teachers felt that students were not always on task during such activities and on most occasions it was difficult to indicate which students were really engaged. With the continued use of small group activities, teachers generally had a change of perception. Although teachers still considered the approach as being time-consuming, they felt that group activities that were well planned were beneficial to students.

The use of group activity is tremendously beneficial to student learning. However, it should not be unconditionally assumed that grouping is an immediate pre-requisite for effective teaching. As indicated by Mc Namara (1994), the method of grouping students is widely accepted as a characteristic of good practice but before decisions are made on grouping students, it is important to weigh its benefits and costs. Mc Namara concluded that there are sound reasons for grouping students but there are equally convincing reasons for not doing so.

He argued that grouping places burden on the teacher in terms of classroom management and organisation. This results in the teacher having less time to attend to teaching and learning.

Mc Namara suggested that in order to provide differentiated learning, it is not always necessary to have students physically place into small groups. He claimed that groups could exist in the teacher's mind and learning activities could be provided for students of different abilities who are randomly distributed throughout the class. According to Mc Namara, students are often grouped based on one characteristic at a time. However, he believed that such arrangement does not get over the fact that students may still be very different in other characteristics that may be related to learning. Mc Namara claimed that it is necessary to strike a balance among whole class teaching and small group activities but in order to do this, the teacher must ask *what is a good balance*? and *how should the classroom be organised to enable the smooth transition from one classroom organisational form to the next*?

A variety of grouping techniques may be utilised in the classroom. However, the technique utilised on a given occasion will depend greatly on the teacher's motives for using group work. In order to minimise student resentment, on occasions, it may be necessary to allow students to select their own group members or to fall into a group at random. Biott and Easen (1996:216) argued that teachers need to work through a systematic enquiry towards understanding the most favourable ways to group children taking into account sex, gender, race and ability differences. However, Mc Namara (1994) argued that certain grouping arrangements such as grouping by background, gender or by friendship choices might amount to discrimination or partiality during group formation.

Although the claims of Mc Namara were essential, one needs to recognise the10 many benefits to physically grouping students. One of the primary benefits is the fact that student interaction is facilitated through small groups. This is particularly true with less able students. Cohen (1986) suggested that group work solves two common discipline problems. Firstly, it assists with problems of the low achieving student who is found doing anything but what he or she is supposed to be doing. Moreover, it helps solve the problem of what the rest of the class should be doing while the teacher is working intensively with a group of students.

5.10: The impact of the innovation on pedagogy

It must be emphasised that it was encouraging that many teachers made progress during the innovation, particularly in the transfer of good teaching habits and in the use of effective questioning approaches. An issue of interest from the research study was the fact that some teachers felt that it was challenging to use open-ended questions since they were used to closed questioning approaches during teaching. As argued by Walker and Adelman (1975), even in open situations, teachers on occasions, create focussed environments for students.

Boaler (1997:22) was of the view that the predominance of teachers' tendency to re-define questions and narrow their scope seems to form the basis of instruction. According to Perrot (1996:252) research studies have shown that the majority of teachers' questions call for specific factual answers or lower cognitive thought. She suggested that although both higher and lower order questions have their place in teaching, an over emphasis on lower order questions encourages rote learning and does little to develop higher order thinking processes in

students. Bonnett (1995) argued that allowing students to think is harder for the teacher than instructing them since the teacher must also be open to thinking.

Many teachers indicated that students' responses were in greater depth when asked open-ended questions. This would indicate that the quality of students' responses is highly dependent on the quality of questions asked by the teacher. This argument was supported by Teacher **12CM** in his view that '*...the questioning strategy used by the teacher determines the kinds of responses that students give*'. The teacher also suggested that given adequate thinking time, students answers were always more sensible. According to the teacher, '*...it's all about the questions asked and the way they are asked'*. It would mean, therefore, that training on appropriate questioning strategies is essential in order to get the most in terms of student learning.

In addition to a change in teachers' questioning approach, there was also an increase in instances of praise and improvement in various aspects of lesson delivery. Costa (1992) believed that through the teaching of thinking, teachers are able to transfer positive teaching strategies to other subject areas and are willing to utilise a wider range of teaching styles. According to Baumfield (2000), the focus on teaching thinking skills is a particularly powerful catalyst for professional development and reflection, because classroom interaction engendered and supported by these pedagogical strategies make teaching and learning more explicit and accessible to learners, as well as teachers.

It was also discovered that many teachers equated difficulty with challenge indicating that Mathematics is difficult and hence sufficiently challenging. According to teacher **2AM** *'...students hate Mathematics because it is difficult and that is challenge enough'*. This would mean that teachers did not necessarily extend students' thinking but merely attempted to ensure a degree of difficulty in assigned tasks. Fisher (1998) claimed that there is an absence of thoughtfulness and cognitive challenge in classrooms and as such, there is the need for clearer and more definitive guidelines in helping children to think for themselves. Hence, learning to think should not be left to chance.

5.11: Teacher collaboration and reflection on practice

The study revealed that teachers did not always consider issues of teacher growth during reflection on practice. Before active intervention, many teachers equated reflection with limitations of practice. However, during active intervention, they mainly viewed reflection as an evaluation of student behaviour that is not directly related to teacher performance. Teachers' initial perceptions might have been attributed to unfamiliarity with the concept before active intervention. However, it was interesting that although teachers were given guidelines for reflection that concentrated on teacher limitations as well as good teaching practices prior to active intervention, they still concentrated mainly on students' attitudes, often with no direct link to teaching practice.

In addition, teachers felt that inadequate time was provided for teacher reflection. Teachers argued that they should be given less of a workload during teaching so that they could spend more time reflecting. According to Teacher **13CM,**

'*...instead of all the paper work ... they* [The Education Division] *should change these and make them opportunities for teachers to reflect so that the teacher could use his or her time doing things that will help make him or her a good teacher instead of just ...being aware of the need for accountability.*'

This viewpoint was of some interest since one of the main arguments in the need for accountability in education is the enhancement of professional practice and subsequently, student learning. One could therefore argue that if teachers believe the avenues for arriving at this objective are misguided, then the existing use of elaborate and bureaucratic systems of record keeping during the teaching process might be considered futile.

The study further revealed that teacher collaboration, to a great extent, focussed on sharing materials for future lessons and discussing problems with difficult pupils as opposed to issues relating to teaching and learning. As stated by Hargreaves (1994) when collaborative cultures become bounded or restricted, teachers focus on safer activities of sharing resources materials and ideas without reflecting on values, purpose and consequences of what they do or without challenging each other's practice, perspectives and assumptions.

It must be noted that the innovation appeared to have contributed to a degree of change in terms of teacher collaboration since teachers eventually recognised the importance of discussing teaching and learning issues and in creating a degree of focus during collaboration. Biott and Easen (1996) suggested that through working and learning together teachers develop a sense of who they are and what they can and cannot do. They also learn about their own and each other's strengths and weaknesses as revealed in particular circumstances and contexts.

5.12: Conclusion

The study set out to determine the extent to which the teaching of thinking contributed to teachers' professional development in terms of potential changes in beliefs and practices, as well as teachers' ability to reflect on their practices. Although the innovation was not as successful in the longer term as anticipated, there was a degree of change in teachers' perceptions and practices on the teaching of Mathematics.

The results revealed that individuals are different in many aspects and teachers' perceptions and practices might differ based on personal attributes as opposed to experience or training. In addition, although some schools were at an obvious advantage in terms of availability of resources and trained staff, there appeared to be greater variation among teachers than there was among schools. Hence, the availability of resources might not be as essential in terms of teachers' practices as often portrayed. The research also concluded that sustained growth was none existent in the schools under study. Some teachers felt that the usefulness of the innovation was not worth the degree of effort on their part. Further, all teachers appeared to have an external reason for their inability to sustain practice.

CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS

6.0: Study conclusions

The research study involved the implementation of a cognitive intervention programme at three secondary schools in Dominica in order to assess:

- *The extent to which it contributed to the professional development of teachers in terms of their ability to reflect on practice.*
- *The degree of change (if any) in teachers' beliefs and/or practices as a result of the innovation.*

Based on a comprehensive analysis of research findings, it was discovered that the secondary Mathematics teachers under study shared concerns relating to the current educational system and more specifically, the nature of curriculum and assessment frameworks. Teachers generally felt that insufficient time was given to curriculum coverage in consideration of the depth and scope of the current school curriculum. In addition, teachers felt neglected in terms of pre-service teacher training, in-service support and the provision of materials to facilitate lesson delivery.

Based on proposals set out in Dominica's Education Act (1997) and the Education Development Plan (2000-2005), one could conclude that the Ministry of Education is committed to improving the quality of education on the island. It must be conceded that there has been improvement in the Education system of Dominica in recent years. However, there is still much to be desired of the current Education System. Consequently, before the Ministry's

vision of *'high quality education for all'* is achieved, a number of measures need to be implemented at Ministerial, District and school levels. Hence, the following measures should be given due consideration.

6.1: Recommendations for improving education in Dominica

A number of initiatives could be implemented in order to improve the current Education system in Dominica (Fig. 6.0).

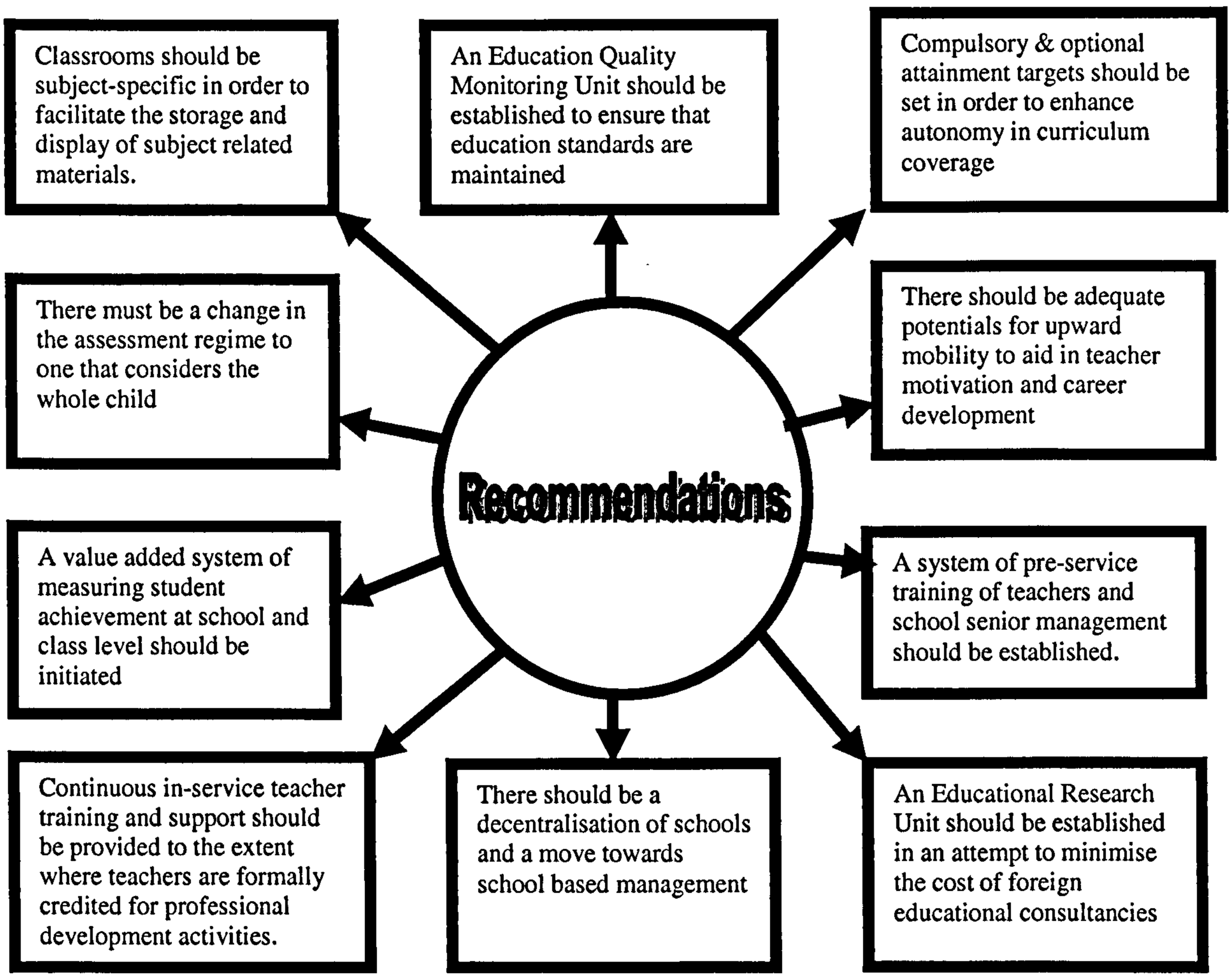

Fig. 6.0: Recommendations for enhancing the Education system of Dominica

6.1.1: Quality Assurance

Based on the results of the research study, one of the primary concerns was the inadequacy of schools' efforts in preparing students for an increasingly competitive world of work. It is generally agreed that students in Dominica are not taught the skills necessary to effectively carry them through life after school (Henry 2002). Many teachers concede that students are weak in their ability to think. However, this could be directly related to didactic instructional strategies that are used on a day-to-day basis. This means that the quality of education in Dominica needs to be closely monitored so as to ensure that students are equipped with the necessary skills to facilitate the acquisition and subsequent utilisation of information.

An essential component in the move to improve educational standards in Dominica is the establishment of an *Education Quality Monitoring Unit* (EQMU). Among its primary duties, this unit would be responsible for ensuring a high quality of education on the island. Currently, there are no quality assurance measures in Dominica and as such education provision varies greatly from school to school. The establishment of the EQMU would clearly reflect the vision of the Ministry of Education '*high quality education for all'* (EDP 2000-2005).

The Education Quality Monitoring Unit would comprise individuals from various units within the Education Department including, representatives from School Supervision and Operations, Education Planning Unit, Curriculum, Measurement and Evaluation, Teachers' Training College and the Project Management Unit. The main responsibility of the EQMU would be quality assurance. This would be done through monitoring the effectiveness of school

supervision and management, teaching and learning and provisions for pastoral care, among other functions.

6.1.2: Educational Research and Programme Evaluation

Although this was not a major issue in this research study, a major problem in education in Dominica is the lack of educational research data. Since many education initiatives are implemented without adequate assessment, teachers tend to view educational innovations as occurring in rapid succession with little or no regard for teacher perception and input. Hence, the impact of educational programmes are not effectively assessed or objectively verified. In light of the above concerns, the Ministry of Education should establish an Educational Research Unit (ERU) to conduct more effective educational research and programme evaluation so as to reduce the high cost of foreign contracts for educational consultancy reports in Dominica.

The Education Research Unit, among other duties, would coordinate the actions of the Education Quality Monitoring Unit. In addition, the ERU would be charged with the promotion of teacher *action research* in the classroom. Since it is often argued that teachers should expose their practice to critical assessment, then action research would be an appropriate way of enhancing teachers' practices. An additional responsibility of the ERU would be programme evaluation within all units of the Education Division.

6.1.3: Decentralisation of Education in Dominica

Currently, government controls most aspects of the education system in Dominica. This means that whenever decisions are taken, there is minimal input from those who are expected to implement changes. Having recognised their limited input in decision making, Dominican teachers are less receptive to ensuring that education initiatives are successful. Hence, attention should be given to the decentralisation of the Education system in Dominica. With the decentralisation of the Education system, schools would be afforded a greater degree of autonomy, and potentially there would be greater efficiency in the management of education on the island.

Through the above initiative, school authorities would be charged with the preparation of school budgets and the utilisation of funds in the most efficient manner based on schools' needs. These authorities would also be charged with the recruitment and training of staff. This would probably result in a greater need for pre-service training so as to ensure that teachers are capable of effective curriculum delivery. This initiative would build on teachers' self-confidence and improve their performance in the classroom. Hence, the government would still maintain control over Education standards but schools would be afforded much of the decision-making potential as to the methods of achieving the set targets.

6.1.4: Human Resource Development

Since education management is a crucial factor in school efficiency and pupil performance, consideration should be given to the mandatory training of school principals before they are allowed to manage schools. Currently, there are principals, both at the primary and secondary

level, with minimal, if any, formal training in educational management. This means that schools are often managed in ways that do not always foster school effectiveness. Therefore, a system of training should be established for prospective school principals and senior management. In addition, in-service continuous professional development should be institutionalised so that school staff constantly update and upgrade professional knowledge and skills.

6.1.5: Teacher support and training

Although in the case of this research study, teacher training did not greatly influence the degree of receptivity among teachers in terms of the implementation of the innovation, one cannot dismiss the need for the pre-service and in-service teacher training. In the Dominican education system, most teachers enter the service with no formal teacher training, inevitably compromising teaching effectiveness. In addition, there are very few in-service personnel working within schools and consequently human resource in this respect is thinly stretched across the island. This means that teachers rarely obtain the degree of support and continuous training that is needed to ensure excellence.

On many occasions in the Dominican context, accountability issues are afforded greater importance than teacher development. Although accountability issues are essential to school effectiveness, there should be a compromise between addressing teachers' professional development needs and the need for teacher accountability. This means that teachers should be allowed more time to reflect on practice since reflection serves as a catalyst for teacher improvement.

6.1.6: Student Assessment

In past years school performance in Dominica has relied heavily on the quality of students upon initial intake and therefore schools maintain a degree of preference in student selection. In order to obtain an unbiased view of the performance of all secondary schools in Dominica, a value added system should be established. This could be undertaken both at the school and class level. On a class level, students could take a baseline examination established from a series of attainment targets upon entry to a particular form or year group. The accomplishment of attainment targets would be re-examined towards the end of the period at that level so as to establish the value added to each student's learning during the period under review. Hence, every teacher would be held accountable for the degree of learning achieved by each student under his or her care. The data from a class level could be accumulated to represent the school's value added performance.

With the above initiatives, a change in the assessment system would also be necessitated. Currently, the assessment system, both locally and regionally, measures to a great extent the 'products' of learning and such, largely neglects the 'processes'. Consequently, many secondary teachers in Dominica feel pressured to complete the school curriculum so as to get students ready for local and regional exams. It is not surprising therefore that many teachers utilise past examination papers as a method of instruction. This method of '*teaching to the test'* at times ensures student success in the contents of the examination but most of these individuals might find it difficult to cope on the job market.

6.1.7: Curriculum Development

Another aspect of education worth considering in the Dominican context is the provision of a degree of autonomy to schools in terms of the scope and depth of curriculum coverage, while maintaining a degree of standardisation in the contents of the curriculum. Currently, the examinations framework places pressure on teachers to cover huge amounts of content prior to the examination. Schools could be given a degree of autonomy through the provision of compulsory and optional attainment targets. This means that schools would be able to decide the scope and coverage afforded to each attainment target and its degree of relevance to students. The examination system would test skills from a variety of both compulsory and optional targets to provide a balance reflection of students' life at school. With such autonomy over curriculum coverage, teachers would be less inclined to 'teach-to-the-test' and would demonstrate a greater willingness to prepare students for successful integration into the world of work.

6.1.8: Schools' Routine Activities

It also seems fitting to implement changes in the routine activities of secondary schools in Dominica. As seen from post-intervention interviews during the research study, teachers felt that they were unable to utilise teaching aids in the classroom since classrooms were used for several different subjects during the school day and hence mobiles and other subject related teaching resources could not be left in these rooms. In order to facilitate the use and storage of teaching aids in the classroom, Departments should be physically delimited. This means selected rooms should be used for specified subjects. Hence, several year groups or forms could use a few classrooms designated to one subject. This would mean that both teachers and

students at all levels would have to move between rooms during the school day as opposed to the current practice where the teacher moves from one classroom to the next. The latter might have implications for classroom management and discipline and as such the school's discipline policy would be a vital instrument in laying the groundwork for student behaviour between lessons.

6.1.9: Teacher Motivation

As suggested in this study, the *self* is an essential component in teacher performance. Hence, teacher motivation is essential to improved performance. Motivation can be enhanced through a variety of measures. Firstly, there could be an increase in the potentials for upward mobility. In many cases, teachers practice for decades with little or no incentives for improved performance. Hence, structures need to be established so that teachers receive opportunities for growth and recognition throughout practice. One such incentive could be a system of teacher motivation where individuals are credited for their participation in professional development courses. This could be in the form of points that would in turn contribute towards certification, promotion or increments for those who are actively involved in educating students.

In order for the above initiatives to be successfully implemented, there must be a paradigm shift from a culture of *traditionalism* to one of *progressivism*. This means that all the stakeholders in education need to redefine their perceptions and practices in a manner that would embrace change and reflect the changing role of schools. Indeed, this shift may not be

as unattainable as one may perceive, since some of these changes are already in the making, however slow their pace.

6.2: Recommendations for further study

It must be noted that this research study is by no means conclusive and hence there is always a need for further studies of this nature. Future research studies should include a greater proportion of secondary schools in Dominica so as to obtain a greater representation in terms of the results achieved. It would be interested to conduct research while ensuring that potential limitations such as lack of teacher training, pressures to complete the curriculum and unavailability of resources are minimised. In addition, the study should be undertaken for a much longer period so as to assess the long-term impact of the introduction of thinking skills on teachers' practices.

SUMMARY

In preparing students for an ever-changing world, they need to be taught how to take control of their own thinking and learning. According to Dean (1991:1), we are currently in the midst of unprecedented changes in education and a great deal that we are currently teaching in school, if not already outdated, will become so in the very near future. Dean argued the speed of change and the explosion of knowledge are requiring people to learn afresh at intervals throughout their lives. The latter has implications for the role of schools, which is no longer that of providing a body of knowledge and content to serve a person for life. Dean claimed that today's children require a level of knowledge that enables them to fit new learning into a coherent framework but above all, they need to know how to sort out information so that they can apply it to new situations.

The goal of improving teachers' practices cannot be pursued in isolation since teachers' professional development and subsequent improvement of practice are directly linked to students' learning. The teaching of thinking represents a powerful tool both in developing teachers' professional practices and in preparing students for a changing world. According to Nickerson (1991:4), there is evidence that traditional schooling is not having the positive impact on students thinking that we would have hoped and might have expected it would have. The development of thinking in students acts as a catalyst for teacher reflection, and reflection on practice serves as a basis for teacher improvement.

In order to aid the effectiveness of thinking skills programmes, the education structure must be conducive to the development of thinking in terms of curriculum and assessment frameworks, as well as in the physical structure of schools and the provision of adequate materials for teachers.

The teaching of thinking is not without it limitations. According to Haynes (2002:1), there is always the danger that thinking skills may be used as a toolkit that can be built and transferred to a variety of contexts and a subsequent risk that these skills will be taught in ways that fail to provoke independence of mind and spirit. Hence, the teaching of thinking should be undertaken as a parallel to instruction. Further, a major concern in the development of thinking is the availability of time. The adoption of a process approach to learning takes time and as such any thinking skill programme must consider this constraint.

Although it is essential that schools provide opportunities for students to develop their thinking, teachers also need opportunities to improve their practices. As teachers embark on approaches that empower students, they develop an attitude where teaching practices are questioned and potential limitations are exposed. Hence, teachers' professional development and student learning should occur simultaneously. Teachers need to be given opportunities to reflect on their actions and to open up their performance to critical reviews so as to maximise the potential for improvement. Put succinctly, the teaching of thinking requires a questioning attitude by both students and teachers. This questioning attitude should be adopted by students in constantly probing their learning as well as by teachers in constantly questioning their beliefs and practices in a continuous quest for improved performance.

GLOSSARY

Assisted schools:	Schools that are partially funded by the state.
Basic Education Reform Project:	An elaborate five year education initiative devised by the Government of Dominica for the purpose of restructuring the Education System of Dominica.
Behaviourist approach:	An approach to learning that advocates a stimulus-response model with an emphasis on rote learning, the use of memory, drill and practice the use of rewards and punishment to control students' behaviour
Caribbean Examination Council (CXC):	The regional examination body responsible for assessment towards at the end of secondary education in the Caribbean.
Cognitive Acceleration in Mathematics Education (CAME):	A cognitive intervention programme infused in Mathematics Education, which is designed to enhance students thinking skills.
Cognitive intervention:	Manipulating experiences specifically aimed at maximising the development potential of students.
Common Entrance Examination (CEE):	A National Examination taken by students who are eleven years of age, which determines entry to a secondary institution in Dominica.

Comprehensive primary education:	Mandatory primary education for all students of primary school age.
Comprehensive secondary education:	Compulsory or guaranteed secondary Education for all students of secondary school age.
Constructivist approach:	An instructional approach where students are allowed to take ownership of, and to actively contribute to their own cognitive development through independent learning.
Differentiation:	The teacher's ability to adapt the curriculum to meet the cognitive, social and moral needs of every child in the classroom.
Formal operational thinking:	The development stage where individuals are able to generate an idea about events already described through concrete operations.
Instruction:	The provision of knowledge and skills through appropriate activities. Instruction can be categorised by topic and domain and the end product specified in terms of learning objectives.
Knowledge based curriculum:	A course of study that considers the provision of knowledge as the central focus of the curriculum.
Metacognition:	The ability to think about one's own thinking.
Public schools:	Schools that are completely managed by the state.

Social constructivism:	A learning theory that suggests individuals interact with the outside world and learn best through social settings.
Teach-to-the-test:	Designing instruction to mirror the contents of an examination.
Thinking Maths lessons:	A series of thirty lessons infused in the area of Mathematics Education, which make up the CAME intervention strategy. The lessons are designed to assist students develop thinking skills.
Traditional lessons:	The term is synonymous with normal lessons. It refers the didactic instructional approach which is utilised on a regular basis throughout the school year.

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APPENDIX: A

EXCERPTS FROM EDUCATION DEVELOPMENT PLAN

(2000-2005)

EDUCATION DEVELOPMENT PLAN

2000-2005 AND BEYOND

WORLD CLASS EDUCATION

for

THE 21ST CENTURY

REVISED

JULY 2001

Education Planning Unit
Ministry of Education, Sports & Youth Affairs

PAGE NUMBERING AS ORIGINAL

VISION, MISSION, PRINCIPLES AND VALUES

The plan is underpinned by a vision that is grounded in lessons learnt from past experiences and current realities. It is inspired by the projections about future challenges and possibilities. Above all the plan is driven by the faith, which we as a nation have placed in the potential of sound education and training for boosting economic development, protecting, enriching and sustaining what is best in our cultural heritage, and acting as a defence against any decline in moral values.

As we begin the 21st century there is broad-based agreement that the education we provide for our children will determine our future role/position in the community of nations, the character of our society, and the quality of our individual lives. Education, thus, has become the most important responsibility of our nation, with an imperative for bold new directions and renewed commitments.

To meet the global challenges this responsibility presents, the Ministry of Education, Sports and Youth Affairs will provide the leadership necessary to ensure access to a dynamic system of education and training from early childhood to tertiary education.

VISION STATEMENT

The vision is one of:

High Quality Education for All

To this end the Ministry commits itself to the following:

- All students will have equitable access to high quality education at all levels with adequate flexibility and **"second chance"** provision which encourages meaningful learning

- The quality of education will be improved at all levels in order to raise student achievement to meet established educational standards, based on measurable results and **bench marked against the best in the world**

- The skills, abilities and aptitudes of all individuals passing through the education system will be developed to the fullest extent

- Each child will receive the support necessary to enter the school system ready to learn and progress successfully through. The Ministry of Education, Sports and Youth Affairs will serve as a leader in collaborative efforts among public and private agencies so that comprehensive, and coordinated service reach children and their families.

- Schools/Institutions and classrooms will be modernized through wider use of information and communication technologies to minimize digital and development gaps, among peoples and between communities

- All students will attend schools, which effectively use technology as a resource to support student learning and improve operational efficiency.

- Schools will be at the centre of change. Strong leadership will be developed and teams of well trained, competent and dedicated staff will work in partnership with students, parents and the community to provide safe, secure and enabling environments to ensure that every student is prepared to succeed

- Classrooms will be well resourced to promote student-centred teaching and learning

- Students will be served by an education delivery system, which focuses on and meets the needs of all students.

- Management of the education system will promote efficient and effective use of resources, and support schools in the transformation process.

- All citizens will be literate, life long learners who are knowledgeable about rights and responsibilities of citizenship.

- Education and training will offer students a passport to jobs, hope, opportunity and growth in the 21st century while simultaneously contributing to social and economic development within the context of a global community.

MISSION

The mission statement of the Ministry of Education, Sports and Youth Affairs is to:

> **"Guarantee equitable access to high quality Education and training to develop in all citizens the capacity to lead productive and fulfilling lives in a complex and changing society".**

This mission is based upon beliefs regarding

Student:

- Each student has an equal right to education
- Each student is an individual with unique needs, abilities and talents
- **Each child has the ability to learn**
- Each student has a natural curiousity which must be encouraged and nurtured
- Students learn more effectively when they have a positive image of themselves
- Students are more likely to achieve their full potential when challenged

Learning and teaching

- Basic skills and knowledge are foundations of education
- The curriculum should emphasize the skills of thinking, creativity, problem solving and self management
- The pursuit of physical well being, a healthy life style, appreciation of the arts must be fostered
- Awareness of and responsibility for the environment must be integrated into all programmes
- Effective teachers care about learners and learning
- **Teaching is a challenging profession requiring competent, talented individuals, committed to ongoing professional development**

School, Staff and Community

- Schools/institutions must focus on students and their learning
- Schools/institutions must provide a caring and stimulating environment which is safe and disciplined
- Schools/institutions must model and promote respect and understanding among all groups
- Collaboration, cooperation and dialogue among students, staff, families and the community greatly enhance the education process and the quality of learning
- Each individual is entitled to fair and equitable treatment
- Schools/institutions must celebrate our Dominican and Caribbean identity
- Each employee is a valuable contributor to the learning environment
- Schools/institutions must promote attitudes and values which enable students to contribute productively as Dominicans in a global community
- Schools/institutions are learning organizations
- **Schools will teach students "to learn how to learn"**
- Schools must provide appropriate and adequate opportunities for students to think analytically and creatively, and be able to solve problems to meet personal, social and academic needs.

The Ministry of Education, Sports and Youth Affairs

Must

- ❖ be proactive in its approach to the management of the education enterprise
- ❖ articulate a strategic vision of the future and provide a regulatory, advisory and supportive framework
- ❖ be accountable, transparent and fair in its operations
- ❖ be service oriented
- ❖ embrace a participatory and team approach to management
- ❖ develop administrative and management capacity through recruitment and training and retraining
- ❖ utilize diversified information systems adapted to the needs of all actors

"Where we have been and where we are,
Is not where we are headed.
We must lift our eyes to the horizon
And see the magnitude of the coming transformation."

Pollock
Senior Planning Officer
EPU 2001

APPENDIX B

EXCERPTS FROM THE 1997 EDUCATION ACT

(COMMONWEALTH OF DOMINICA)

(w) keeping under review the work and organisation of the school;

(x) evaluate the standards of teaching and learning in school, and ensure that proper standards of professional performance are established and maintained;

(y) maintain good order and discipline among the students and safeguard their health and safety both when they are authorised to be on the school premises and when they are engaged in authorised school activities elsewhere.

(z) perform any other related duties which may be prescribed by Regulations made by the Minister under this Act.

(2) A principal who fails to perform any or a combination of the professional duties specified in subsection (1) is liable to disciplinary action in accordance with prescribed Regulations respecting discipline.

PART VIII

CURRICULUM AND ASSESSMENT OF STUDENTS

National curriculum.

137. (1) The Minister shall establish a national curriculum for public schools and assisted private schools.

(2) A curriculum established under subsection (1) must be balanced and broadly based and must, in addition to the goals and objectives specified in section 4(2) –

(a) promote the spiritual, moral, cultural, intellectual and physical development of students and of society; and

(b) prepare students for the opportunities, responsibilities and experiences of adult life.

(3) The Minister may revise the national curriculum whenever he considers it necessary and expedient to do so.

Core and foundation subjects.

138. (1) The curriculum for every public school and assisted private school must comprise core and foundation subjects and specify in relation to each of them –

(a) attainment targets that include the knowledge, skills and understanding which students of different abilities and maturities are expected to have by the end of each key stage;

(b) programmes of study that include the matters, skills and processes which are required to be taught to students of different abilities and maturities during each key stage; and

(c) assessment arrangements that include the arrangements for assessing students at or near the end of each key stage for the purpose of ascertaining what they have achieved in relation to the attainment targets.

(2) Subsection (1) does not apply in the case of a school engaged in the delivery of special education.

Key stages of assessment.

139. (1) The key stages in relation to a student are as follows:

(a) the period beginning with his attainment of compulsory school age and ending at the same time as the school year in which the majority of students in his class attain the age of seven;

(b) the period beginning at the same time as the school year in which the majority of students in his class attain the age of eight and ending at the same time as the school year in which the majority of students in his class attain the age of ten;

(c) the period beginning at the same time as the school year in which the majority of students in his class attain the age of eleven and ending at the same time as the school year in which the majority of students in his class attain the age of twelve; and

APPENDIX C

PROPORTION OF TRAINED SECONDARY TEACHERS AT VARIOUS SCHOOLS IN DOMINICA

Table 4: Student Teacher Ratios in 2001

School	No. Graduates	No. Non-Graduates	Total No. Teachers	Total No. Students	No. Students Per Teacher	No. Students per Graduate
Goodwill	5	29	34	647	19.0	129.4
Grand Bay	6	30	36	685	19.0	114.2
Isaiah	4	34	38	658	17.3	164.5
Dominica Grammar	10	20	30	730	24.3	73.0
Marigot	3	8	11	184	16.7	61.3
Portsmouth	9	31	40	765	19.1	85.0
Castle Bruce	2	19	21	554	26.4	277.0
Nehemiah			11	135	12.3	
St. Andrew's	6	28	34	597	17.6	99.5
Wesley	3	14	17	273	16.1	91.0
St. Mary's Academy	19	10	29	420	14.5	22.1
Convent High	13	18	41	477	15.4	36.7
St. Martin's	3	16	19	310	16.3	103.3
Dominica Community	2	8	10	130	13.0	65.0
SDA	6	5	11	208	18.9	34.7

APPENDIX D

SECONDARY SCHOOL PERFORMANCE AT THE CARIBBEAN EXAMINATION COUNCIL (CXC) EXAMS (1998-2001)

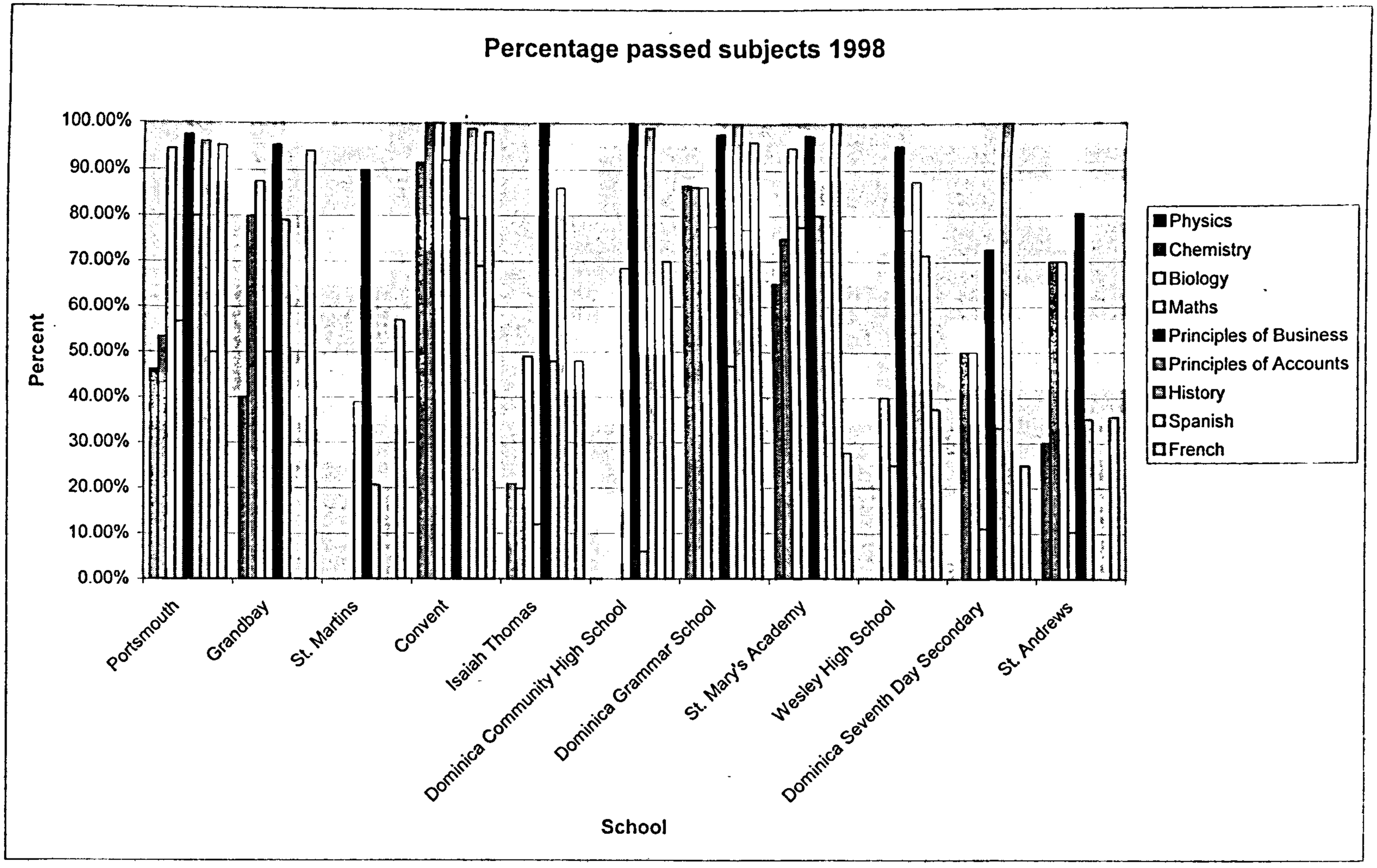


Figure 2: Percentage Passing Selected Subjects, 1998

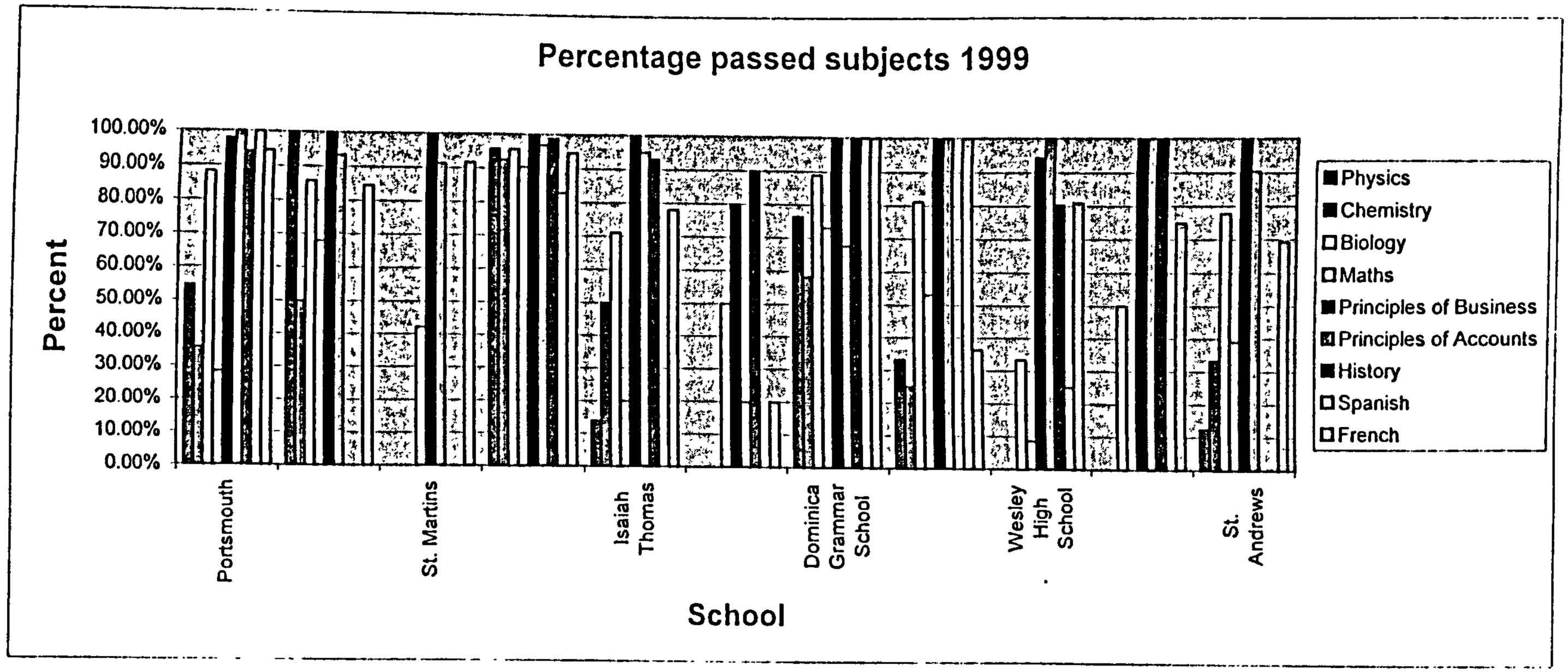


Figure 5: Percentage Passing Selected Subjects, 1999

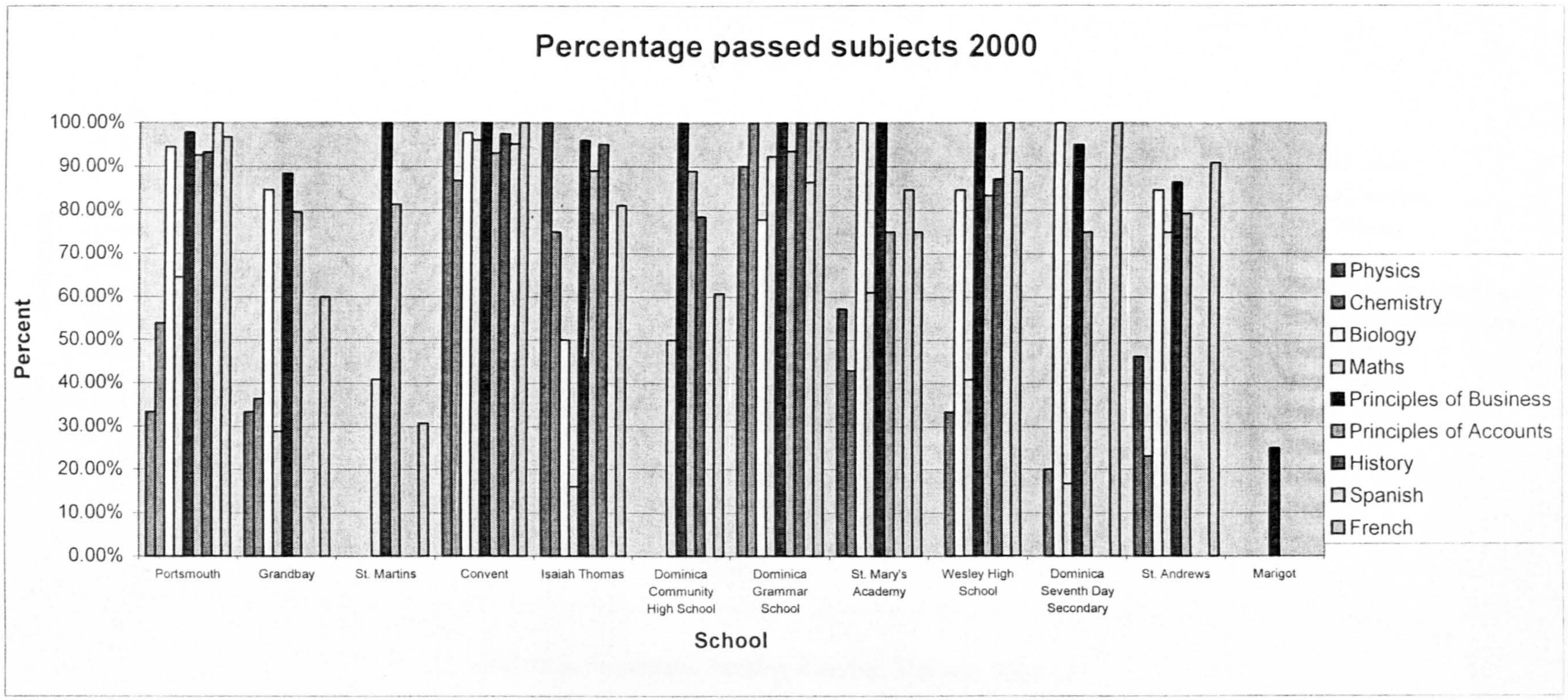


Figure 7: Percentage Passing Selected Subjects, 2000

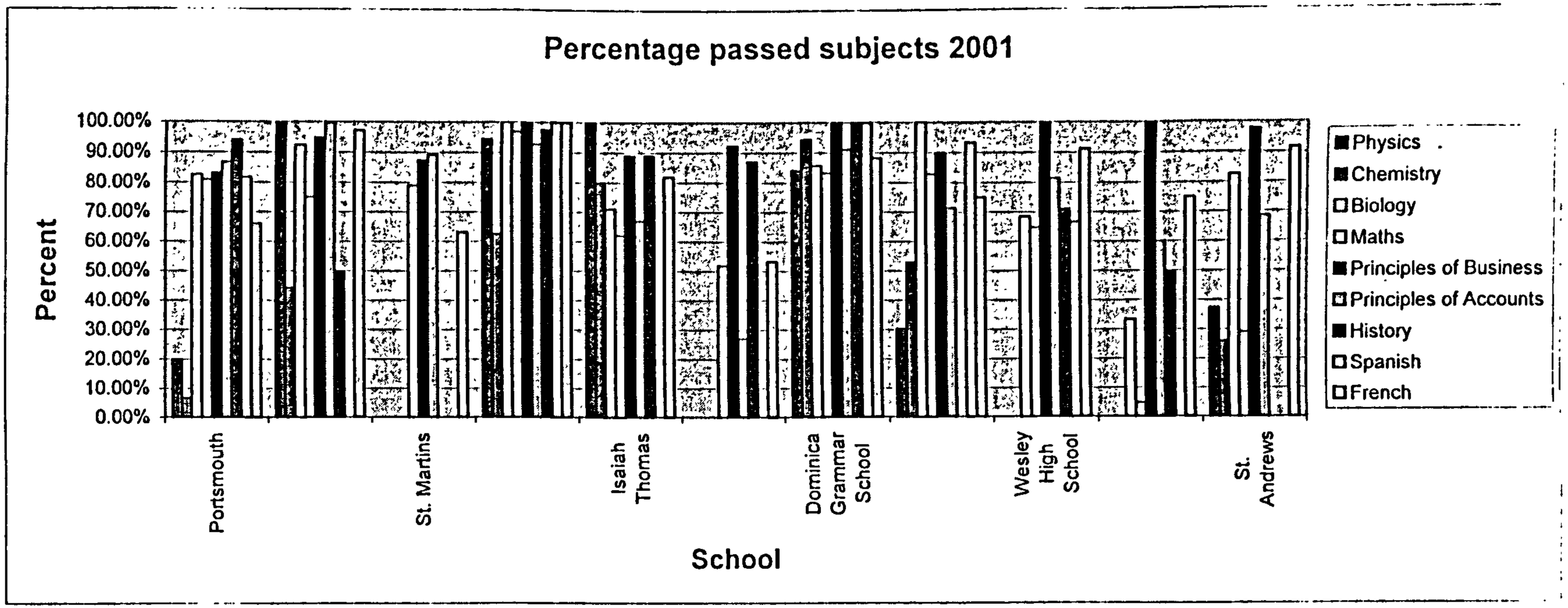


Figure 9: Percentage Passing Selected Subjects, 2001

APPENDIX: E

SAMPLES OF THINKING MATHS LESSONS

2 Tournaments

An activity based on systematic listing, repeated addition, and multiplication as a short cut, set in the context of school sports tournaments.

In the second part of the lesson pupils explore the use of symbols and expressions.

Thinking strands

Systematic enumeration of combinations

Comparing representations

Curriculum links

Exploring algebraic symbols and expressions

Resources

Notesheets 1 and 2

One calculator per group

Lesson summary

1 Introduction (5 min)

Set the problem up for the class. Teams from three schools are playing in a sports tournament, where each team plays every other team at home. How many matches are played in total?

Don't give any particular way of organising the count. Ask how pupils would show on the page that no game is missed or counted twice. Give out Notesheet 1, where pupils should use their methods with four and more schools.

2 Pupils' work (10 ± 2 min)

Circulate to help individuals and encourage them to help each other. Note instances where the method of 'doubling', which produces the right total for three schools is recognised as not valid for other numbers.

3 Class discussion (10 min)

Elicit the different methods of enumeration, and their pros and cons. Move then to generalisation through use of different and large numbers, then to any number. The generalisation should first be made in words, then in symbols.

4 Introduction to Notesheet 2 (5 min)

Start with two examples for the same expression. For example, an uncounted amount of money in a purse from which 2p is taken can be described by the expression $(n - 2)$. The same expression can stand for an uncounted number of pupils who remain seated when you ask two pupils to stand up.

5 Pupils' work (10 ± 5 min)

Circulate, encouraging pairs or group work in creating good stories for the expressions.

6 Class discussion (10 ± 5 min)

Elicit various stories for each expression.

Conclude by repeating the message about symbols and expressions serving as number variables. Use various phrases, for example: number holders, number carriers, standing in for any number, representing any number, envelopes in which any number can be hidden.

Question 8 on Notesheet 2 may be used as an extension or as optional extra work for interested pupils.

Mathematical content

The context for the first activity, based on Notesheet 1, is schools playing sports matches against each other. If every team plays all the others at home, how many matches are played in total? This is a case where the items to be counted have to be listed or represented in a systematic way. Different ways of listing and representing have advantages for different uses. For the purpose of finding the total number of matches, pupils should recognise that some operations have advantages over others (in this case multiplication is more efficient than repeated addition). For the general case of 'any number', symbolisation is gently suggested.

In the second activity, based on Notesheet 2, the use of symbols is explored with emphasis on the symbol as a generalised number and its use in expressions. This part of the lesson starts with a class discussion with some instruction.

Pupils' thinking

The mathematical content provides another context within which pupils can work towards the language of generalised number. It also develops the pupils' concepts of multiplication. The generalisation is achieved through recognising that the different methods of listings and representing contain the same two variables: the number of schools involved, and the number of games each school plays at home. To find the total number of games played the repeated addition can be replaced by a more general multiplicative relationship expressed in words or in algebra.

Part of the agenda for the first activity is to give an opportunity for as many groups as possible to have something worth saying, and which they can demonstrate and discuss.

Specimen lesson

0.00 Introduction

The teacher starts by explaining that the lesson will be about schools playing games with other schools at home grounds, and how to find the total number of games played from the number of schools. What game should they use as example? The class chooses Basketball by a vote.

The teacher elicits names of three primary schools where some pupils came from and lists them on board in a line: Northfields, Trees, Oldham. She asks each pupil to show on a piece of paper their way of finding the number of games played when each of the three schools plays the others at home. She explains that it is important to organise the work, listing or diagrams so as not to miss any game, or count any game twice.

While pupils list or draw their solutions the teacher encourages comparisons between different methods. When most pupils have managed a solution she gives out Notesheet 1 and asks them to work now with four schools. She stresses that they should start with their own preferred method and switch to another only if they find it easier.

0.05 Pupils' work

Some pupils make guesses with the total '8 games' for 4 schools thinking that each school still plays 2 games as in the example with 3 schools. The teacher encourages them to check by listing or drawing. When they realise their mistake, she asks how they did that themselves, and praises their orderly way of counting or listing.

Some pupils use **abbreviations** for schools, some use **colours**, and others **matchstick figures**. The teacher compliments the originality and asks if these make the counting easier and what other purpose they are serving.

For question 2, with 5 schools, some pupils **group** the schools or draw lines around them. Some write the number for each group. These presentation methods indicate some recognition of the generality of the problem, in that it appears similar to other problems which the pupils have solved in the past.

Some pupils start by using lines or arrows **between** two columns listing the schools or **within a single list.**

A variety of methods of grouping and listing used in the class are shown below and on page 10.

For question 3, with 6 schools, some pupils successively add six 5s in some way to find the answer, recognising **addition** as a short cut to counting. Some also use the 'times' operation, recognising **multiplication** as a short cut to repeated addition.

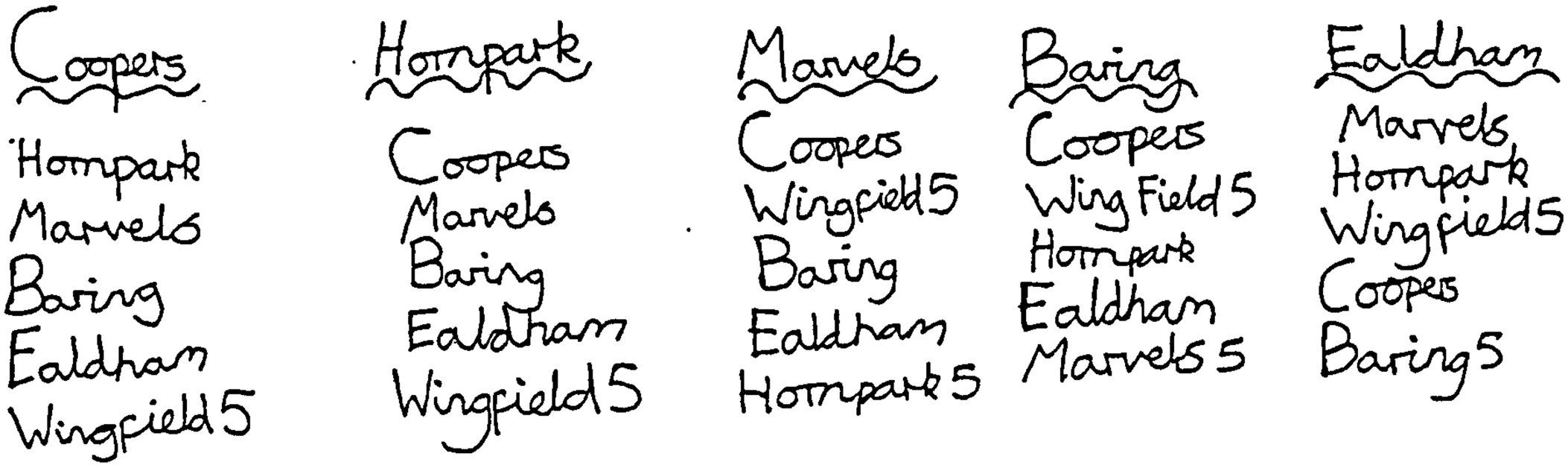
In question 4, the step of going from a solution for a known number of schools to an expression for any number of schools is fraught with difficulties. The teacher allows pupils who reach the question to struggle with it for a few minutes before moving to discussion.

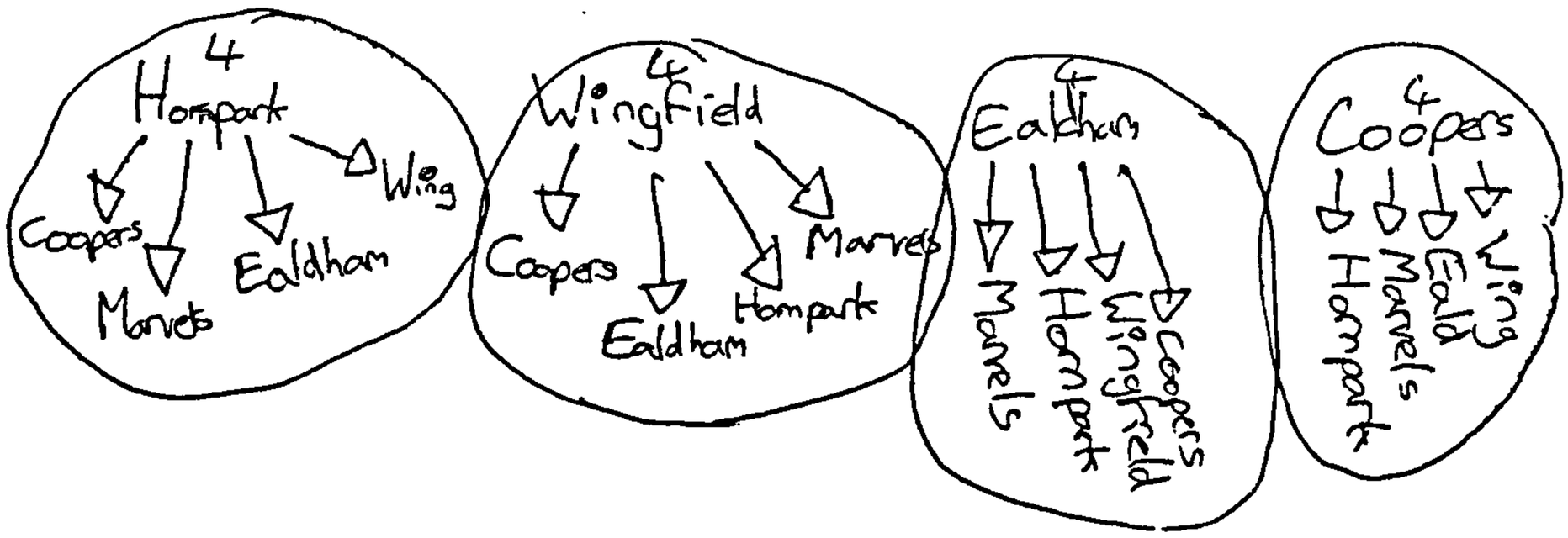
0.20 Class discussion

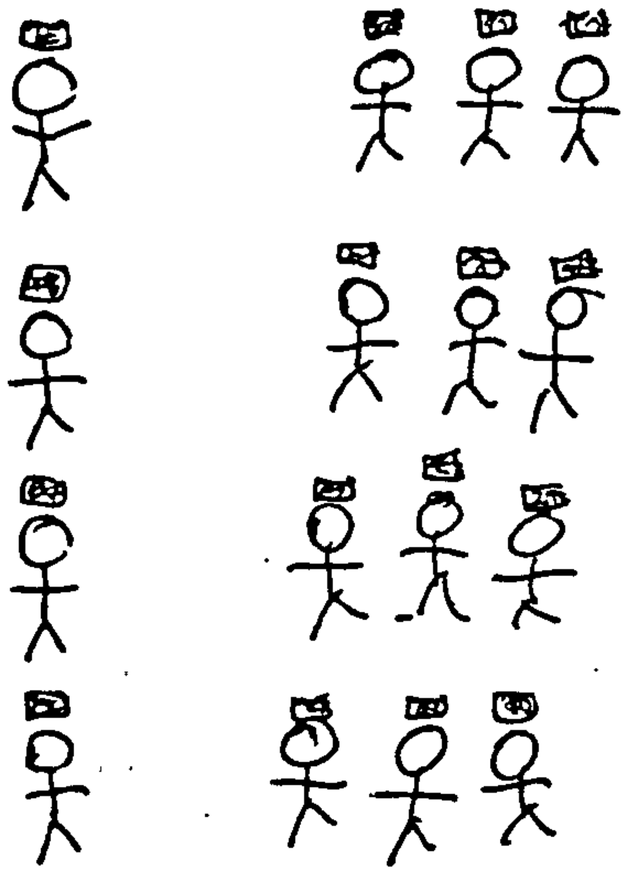
Class discussion focuses on the different methods used, rather than the answers. The teacher conducts the discussion without stressing a preference for multiplication. Each pupil should recognise that he or she has a method and that other methods can be used. The teacher stresses that pupils may prefer one method now, but some other method in a different problem, because it is more convenient.

The teacher lists the methods used by the pupils: the guess with a reason, the list, the grouping, the arrows and lines, the additions and the multiplication. She borrows some pupils' Notesheets to copy their diagrams on the board. Each method

Samples of pupils' work for Question 2, Notesheet 1.



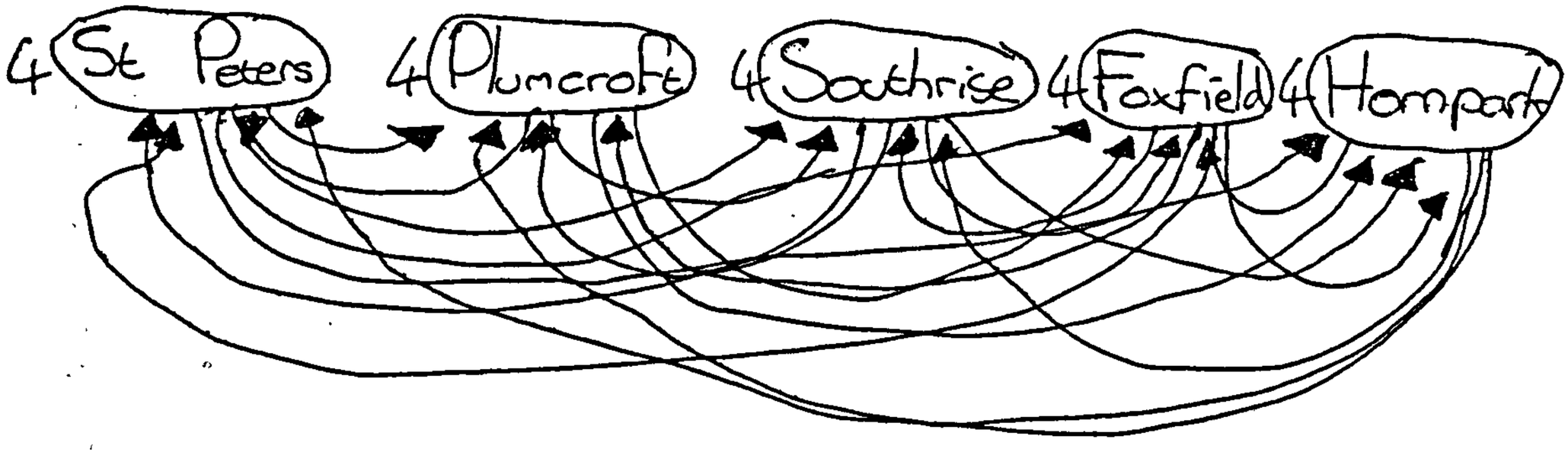


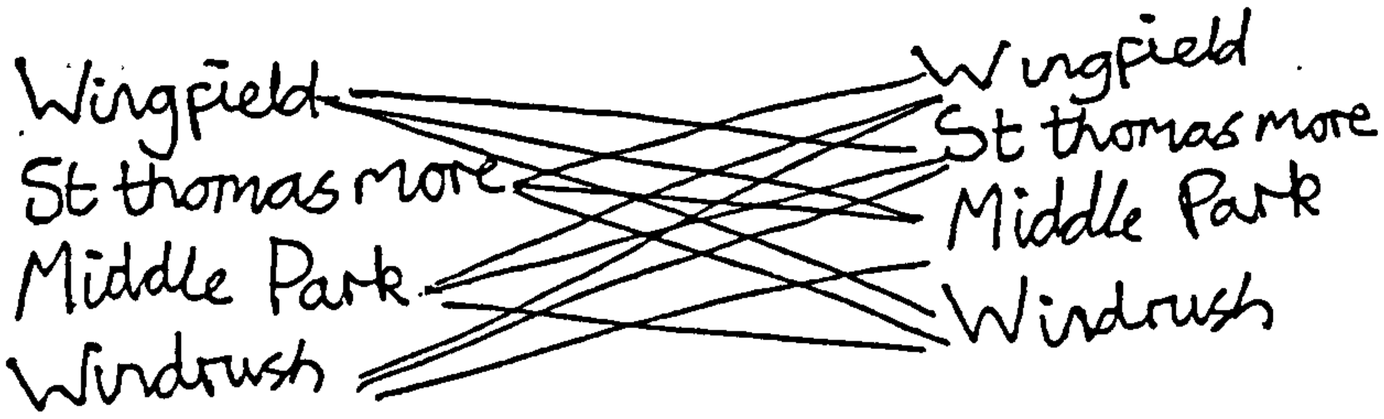


3X4 =12

or

4X3 =12





55
55 30
55
~~165~~

A range of grouping methods pupils used in the TM2 Tournaments specimen lesson

is then looked at in terms of advantages and disadvantages.

The advantage of a **guess with reason** over just a guess is that the reason gives a starting point for checking and realising your own error.

The **list** is best to make sure everybody is counted. However if the number of schools is large, so much writing can lead to mistakes. The list must also be systematic and organised.

Grouping the schools can make listing and counting easier. Adding another school means adding another group, and also adding one to each group.

Lines and arrows make for less writing, and contain the same information as lists. They are mathematically more elegant but may be untidy. An easy way of counting games is to look only at the ends of the lines coming out of each school name (or coming to it), so you have groups of lines. As with the lists, if you add a new school you add one more line to each of the groups, and a new group.

Using abbreviations or symbols is a short cut for writing and makes listing groups easier.

The teacher emphasises: 'Number of Schools', and 'Number of Games each school plays' for each method, highlighting the way they are grouped. She then asks: "What is common between all the methods?" She extracts, with some prodding, that all the methods show the games each school plays and that the total number of games comes either by repeated adding (5 games for each of the 6 schools, 6 games for each of 7 schools etc.) or by 'times'-ing (6 lots of 5, 7 lots of 6 etc.) The teachers dwells on the equivalence of these two calculations, realising the difficulty of multiplication for many pupils at this age.

0.30 Teaching episode

A teaching episode follows on how to find the number of games for any number. Starting with 10 schools, moving on to 20 schools, then to 50 and 100 schools, the teacher gets from the class the number of games each school plays at home, then calculates the total number of games. Some pupils use calculators to check. Then the teacher uses the symbol n for the number of schools, and the expression $n - 1$ for the number of games each school plays at home. The teacher reminds the class they have used variables and expressions like these before to stand for any number.

0.35 Introducing Notesheet 2

The teacher explains that symbols are used for many different things: abbreviations for full names, or labelling flats or rooms A, B, C . She reminds the class that some pupils used letters as abbreviations for school names in their work in Notesheet 1. In all these cases the letter stands only for one thing. But in Algebra we use a letter to stand for **any number**, which is very different. And when you make an expression like $n - 1$, that also can be any number, depending on what number n takes.

She explains that n can be a number of any things: money, or people or schools or pencils. She then gives an example. She gets some coins from her purse in one hand and takes 2p out. She asks: "If I had 40p here before, how much do I have left? What if I had 80p? 77p? 13p? Any number of p's?" She gets them to accept $n - 2$ for that situation.

She quickly gives another example for the same expression. She asks two pupils to stand up, and asks: "If there were 30 pupils sitting before May and Rad stood up, how many are still sitting? What if there were 24 pupils sitting before? 20 pupils? 130 pupils?" She gets the class to realise that the coin and the pupils examples are similar in some way. They can be stories for the expression $n - 2$.

0.45 Notesheet 2

Notesheet 2 is given out. The teacher asks for ideas for question 1, and then for question 2, before asking the class to write their own stories.

Circulating, the teacher encourages pupils to work in pairs and select the best stories they come up with for discussion.

Some pupils have great difficulty with the idea of generalised number and the teacher uses questions such as

"What can letter n stand for here? Give me a possible number. Another number?"

"What number can letter b stand for here? So what does 2 times b make?"

0.55 Class discussion

Pupils share some of the stories they have made for each expression. The teacher picks one from each group.

The teacher praises the class thinking. She suggests some pupils may want to try question 8 at home and come back to her with their stories. This question asks pupils to suggest symbols for a number of things themselves, make an expression by adding or subtracting some number from that, and then to find stories that fit the expression.

2 Tournaments

Notesheet 1

1 4 schools play in a tournament. Each school plays all the others at home.
List the four schools,

..... , ... ,

..... and .....

How many games are played altogether?
How did you work it out?

2 5 schools play in a tournament. Use the same method to find how many games are played altogether. (Or change your method for a better one.)

3 6 schools play in a tournament. How many games are played altogether?

4 What is your way of finding how many games are played by any number of schools?
Explain your way to others in the group to check it is OK.

2 Tournaments

Notesheet 2

Symbols and expressions

1 There are n pupils in a class.
What can $n + 4$ mean? Make up a story.

2 There should be p players in a team.
What can $p - 3$ mean?

3 There were d ducks in the pond. Now there are $d + 2$.
What happened?

4 There were x green bottles standing on a wall. Now there are $x - 1$ green bottles.
What happened?

5 You had b pounds saved. Your rich aunt keeps a promise for your birthday, and now you have $2 \times b$ pounds.
What did your aunt promise?

6 The school has n tables in the dining hall. They have to buy plastic feet for the 4 legs of each table, so as not to damage the new floor. They also buy new chairs, four for each table.
What can $4 \times n$ mean? (Or $n \times 4$?)

7 p is the lottery prize shared by 3 people.
What will each get?

8 **Extension**
Make up questions like the ones on this notesheet.
Follow these steps:

1) Imagine a group of people or things which you have not counted and do not need to count.
2) Decide on a symbol to stand for how many there really are, for example q or y.
3) Using the symbol and numbers write some expressions (like $q + 5$ or $y - 4$).

Make up two or more stories for each expression.

7 Two-step relations

Two different contexts are used for the pupils to generate the two-step linear relation of the type $y = mx + c$. In each case the relation is to be stated in different forms: in ordinary language, in algebra if possible, in a table and in graphs. These forms are then compared.

Thinking strands
Handling generalisations in natural language and various formal representations

Curriculum links
Algebraic and graphical representation of linear functions

Resources
Notesheets 1, 2, and 3

Lesson summary

1 Introduction to Notesheet 1 (5 min)

Either by using a large drawing on the board or by going over question 1, Notesheet 1 with the class, start the class generating the numbers of leaves for different numbers of twigs. This should include going over the case of a branch with no twigs.

2 Notesheet 1 and class discussion (15 min)

In the activity pupils have to express in words how to find the number of leaves by exploring a two-step pattern. They then represent this as a mixture of words and symbols, or symbols only, and record their results in a table.

The class discussion should focus on the move from words to symbols, ensuring that pupils do not make the common error of treating letters as objects rather than number variables. The discussion should also highlight the different ways of representing the same relation: words, a mixture of words and symbols, symbols, and a table of values.

3 Notesheet 2 (15 min)

Black and white tiles is the same work as Notesheet 1 in a different context. Pupils compare their results from the two Notesheets, looking for similarities and differences. The two-step structure of the relation should emerge in group and/or class discussions.

4 Notesheet 3 (15 min)

Pupils plot graphs of ordered whole number pairs, which should not constitute a conceptual difficulty. The patterns of the points as straight lines are then compared. The slope of the line is matched to the multiplier, and the intercept to the constant number.

5 Class discussion (10 min)

The final discussion goes over the modes of representation of the relationships, and their relative merits, based on pupils' answers to question 7 on Notesheet 3.

6 Extension

Pupils explore one or more non-visual contexts of two-step linear relations, through finding actual or realistic values and plotting them. For example:

- fun fair: entry charge plus so much per ride
- taxi fares: basic charge plus so much per mile
- home repairs: call out charges plus so much per hour
- gas/electricity: standing charge plus so much per unit
- cooking time for turkey: 20 min start up plus 20 min per pound.

Mathematical content

The activity focuses on different representations of the relation between two variables, each of which is a natural number. It takes the notion of generalised number one stage further from *TM1: Roofs*, which should have been given a few months earlier.

A common source of errors in symbolisation is the confusion between using a letter as code or short-hand for an **object name** and using it as a **number variable**. This is often unwittingly compounded by the convenience of using the first letters of the names of the objects to which the number variables relate. The difference should be made clear to pupils, for example that

$3t$ does not mean *3 twigs*, but *3 times the number of twigs*. It is suggested that teachers make this distinction repeatedly in this activity, and avoid using the word 'short-hand' unless accompanied by the reference to the number variable, number carrier or number holder.

Plotting the ordered pairs of positive whole numbers is the first step in graphs. In this lesson the straight lines are plotted on separate grids. The two straight lines could easily be plotted on the same grid, but this would mean two sets of labels on each axis, a further generalisation. The extension material contains some suggestions on new relations which higher attaining pupils can explore.

Since the variables in this activity only have whole-number values, bar charts will be valid representations. However, the teacher should direct the pupils to join points with dashed lines rather than making bar charts. Straight dashed line graphs indicate the linear pattern of the discrete data, as distinct from a continuous linear function. The fact that intermediate points on the dashed line are meaningless need not be emphasised at this stage, so solid straight lines should be accepted. Where the activity is extended to contexts where the variables can be regarded as continuous, such as time, the distinction between the two types of linear relationship can be discussed.

Questions 4 and 5 on Notesheet 3 lead to discussing the gradient and the intercept of the straight line graphs. The formal terms may be used, but together with natural language descriptive words like slope/slant and start-up/beginning, or similar.

Pupils' thinking

Pupils produce the patterns to be symbolised from visual data. This is a structured aspect of looking at the world mathematically (starting to devise a mathematical task in Ma1). Since the values are counting numbers the activity is accessible to all. Classes with a higher than average attainment profile should attempt an extension activity involving continuous variables with the same relation.

Pupils find pairs of numbers in a semi-random manner, and the relation between the two variables is found directly rather than from a table. Tables normally focus minds on additive or difference relations, while this activity is designed to formulate two-step relations, one of which is multiplicative. Tables are used only as another way of representing the relationship.

For symbolising, the pupils are asked to make a word formulation of the relationship directly from their experience, moving on to a mixture of words and symbols or symbols only. This follows a widely accepted principle that conceptual learning is maximised when children are exposed to a concept through a variety of embodiments. Hence two contexts are provided in Notesheets 1 and 2.

Specimen lesson

(*Note*: This is a class with a low profile of attainment in the national norm, hence the emphasis on use of letters, and no extension material.)

0.00 Introduction

The pupils sit in pairs within groups.

Teacher: "This lesson is about patterns common in real life, and how to look at them mathematically. It is how to describe things mathematically. Remember, maths is a language, but it mostly uses numbers and symbols."

The teacher shows the first activity on the board, showing that each twig has three leaves, and each branch starts with two leaves at its root.

She draws the two leaves for each branch before saying how many twigs there are. She asks pupils how many leaves there are on a branch with 2 twigs. Most hands up. "What about a branch with 10 twigs?" Some hesitation and fewer hands are up. "This is what today's work is about."

She gives out Notesheet 1, and allows the pupils to work helping each other.

0.15 Class discussion

"Let's see how different people have been doing." The teacher checks that almost everybody has used 'You multiply the number of twigs by three then add 2' in various forms. Then she concentrates on question 3. She writes the various expressions on the board:

$t \times 3 + 2 = l$
$l = t \times 3 + 2$
$t \times l + 2$

Teacher: "What does l stand for here?"

Pupil: "Leaves on the twig."

Teacher: "We know how much that is don't we? So do we still need to use a letter for it? We will come to that later."

Another pupil offers "$2t = 6l + 2l$."

Teacher: "You mean that 2 twigs is 6 leaves plus 2 leaves."

Pupil: "Yes."

Another pupil: "$l = t \times 3 + 2l$."

The teacher explains the common source of confusion with letters. "In maths they are used for number variables, and can be any value. They are not used as code or short-hand for the words." She checks that the last answer is corrected to $l = 3 \times t + 2$.

"There is nothing wrong with using letters as a code or short-hand, but in maths we must be clear and not confuse ourselves. Letters stand for numbers and not as code or objects in algebra. Many people get confused, and we need to be careful. We always need to check that everybody has the same meaning."

Then the teacher shows the convention in algebra that $3t$ means 3 times t which can also be written as $3 \times t$ or $t \times 3$.

0.25 Notesheet 2

Notesheet 2 is given out to pairs.

The teacher shows on the board the pattern with one and two black tiles. She asks about the 2 black tiles, then writes on the board $2b$ and $2 \times b$ as both meaning '2 times the number of black tiles'.

Pupils work much more confidently on this activity, and the teacher circulates stimulating argument on the 'no black tiles' pattern and linking it to the pattern of 'twice the number of black tiles plus 1'.

0.45 Class discussion

The teacher stops the class for discussion. For question 3 she gets:

2 times b plus $1 = w$
$w = b \times 2 + 1$

then

$9b$ times $2w$ plus $1 = 19$.

The teacher takes time and attempts to understand what the pupil means. The pupil had an example of 9 blacks (hence $9b$ in short-hand) times by 2 whites each (that is the $2w$) then plus $1 = 19$. The teacher says "that is very interesting, because the maths in your mind is correct and you are using short-hand that you yourself understand. But we agreed to use the letters to stand for the numbers not the words." The girl seems happy with the fact she was right in the sum at least!

The teacher goes over the steps in thinking for the question on the number of black tiles = zero, using the algebraic expression as well as the pattern.

Teacher: "Let's look at similarities and differences between the twigs and leaves pattern and the tiles: what ideas did you come up with?"

Pupils:

"You times something then add something."

"You have to multiply a number then add the number to get the answer."

"Two steps!"

The teacher asks: "What part in the twigs and leaves is similar to what part of the black and white tiles?" She writes the two expressions on the board underneath each other, and the pupils agree the analogies.

Teacher: "So what are the differences?"

Pupils:

"One of them leaves the other tiles."

"You've got higher numbers with twigs and leaves."

"All the white tiles are odd numbers."

"The numbers are different."

The teacher commends all the answers. She extracts from the 'higher numbers' pupil what she means, i.e. for the same starting number the answer in the twigs problem is bigger.

"Why?"

"Because three times something is more than twice something."

From the answer "The numbers are different" she clarifies that the girl means the numbers to multiply by are different, but the number of black tiles can be the same as the number of twigs. However they are multiplied by different numbers, and then different numbers added.

1.05 End of lesson

The teacher says they are going to plot graphs of the two patterns in the next lesson, using the third Notesheet.

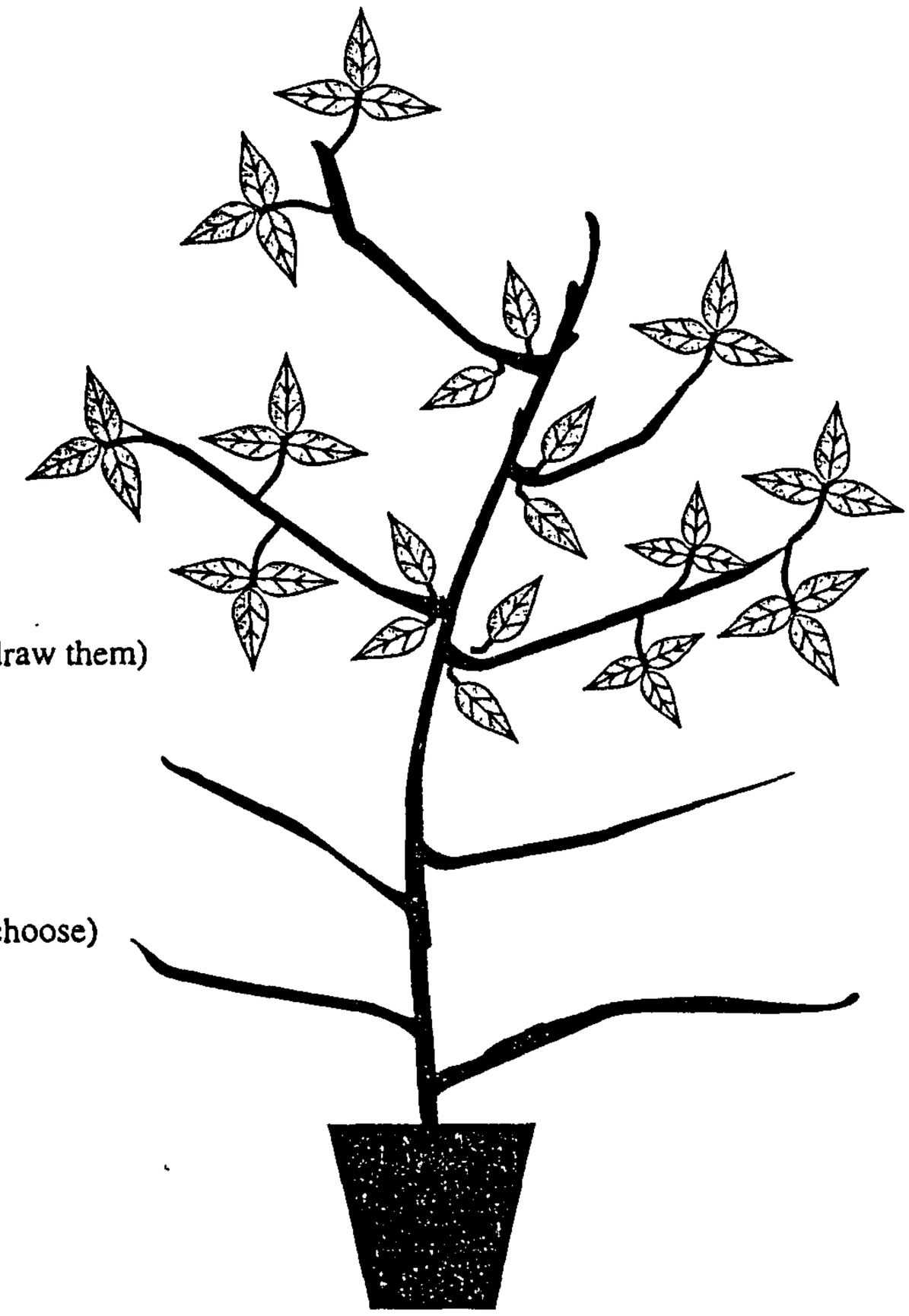
7 Two-step relations

Notesheet 1

Twigs and leaves

Twigs: _____

Leaves: _____



Twigs: _____

Leaves: _____

Twigs: 5 (draw them)

Leaves: _____

Twigs: _____ (choose)

Leaves: _____

Twigs: _____

Leaves: _____

Twigs: _____

Leaves: _____

Twigs: 0

Leaves: _____

Twigs: 100

Leaves: _____

2 Complete this sentence to explain how to get the number of leaves if you know the number of twigs:

Number of leaves = ... add .....

3 Write the sentence in symbols.

Let *t* stand for number of twigs, and *l* for the number of leaves.

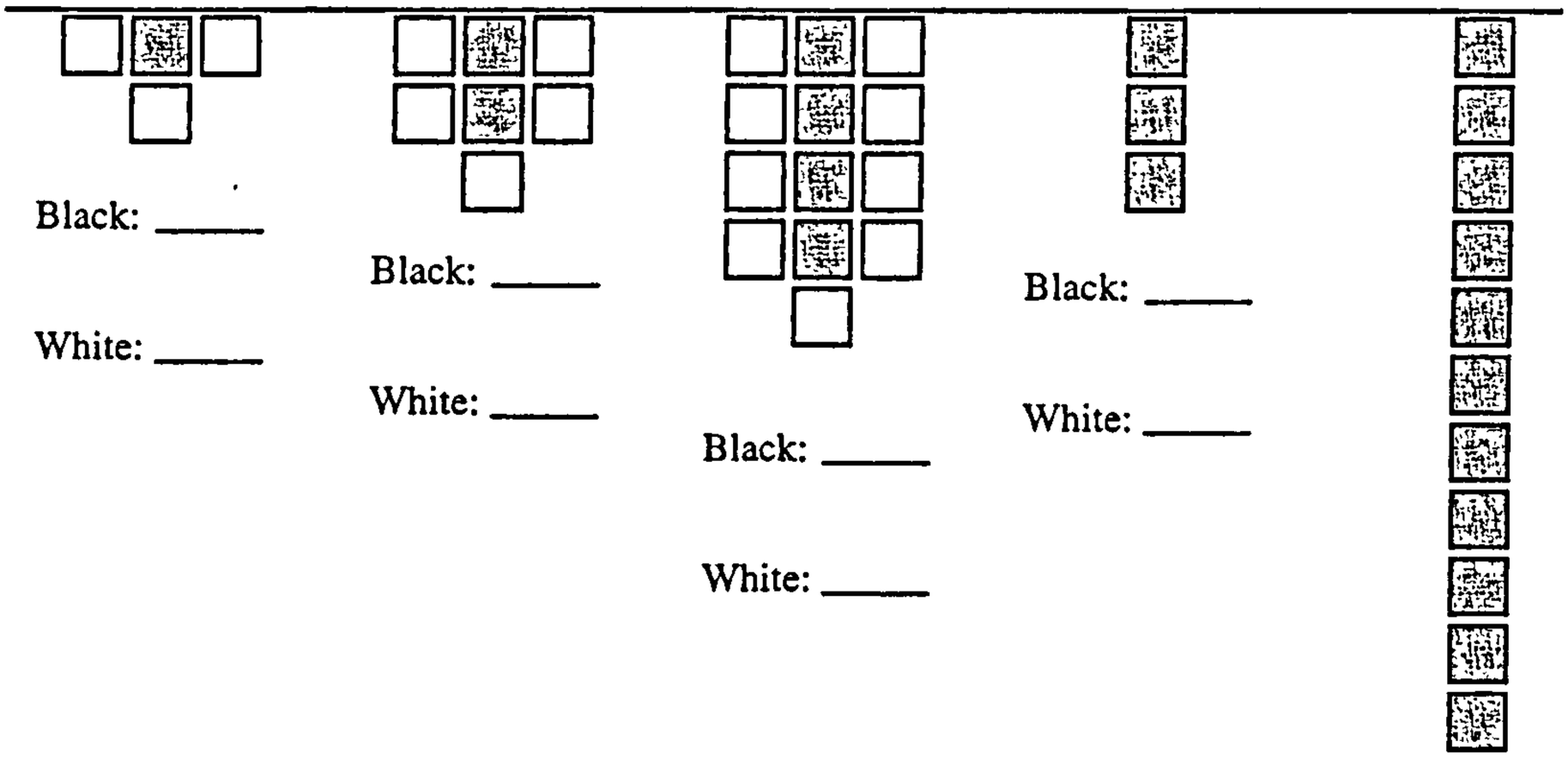
4 Fill in the table with your results in some order:

Number of twigs	0	1						
Number of leaves								

7 Two-step relations

Notesheet 2

Black and white tiles



1 Fill in the number of black and white tiles for each group. You may need to draw white tiles for the last two.

2 Fill in the number of white tiles for:

100 black tiles	_____ white tiles
17 black tiles	_____ white tiles
333 black tiles	_____ white tiles

3 Complete: Number of white tiles = ... + ...

4 Write your expression in symbols.
Use w for the number of white tiles and b for the number of black tiles.

5 How many white tiles if the number of black tiles is zero?

6 Fill in the table with your results, in some order:

Number of black tiles	0	1					
Number of white tiles							

7 Compare the black and white tiles pattern with the twig and leaves pattern.

(a) What is similar?

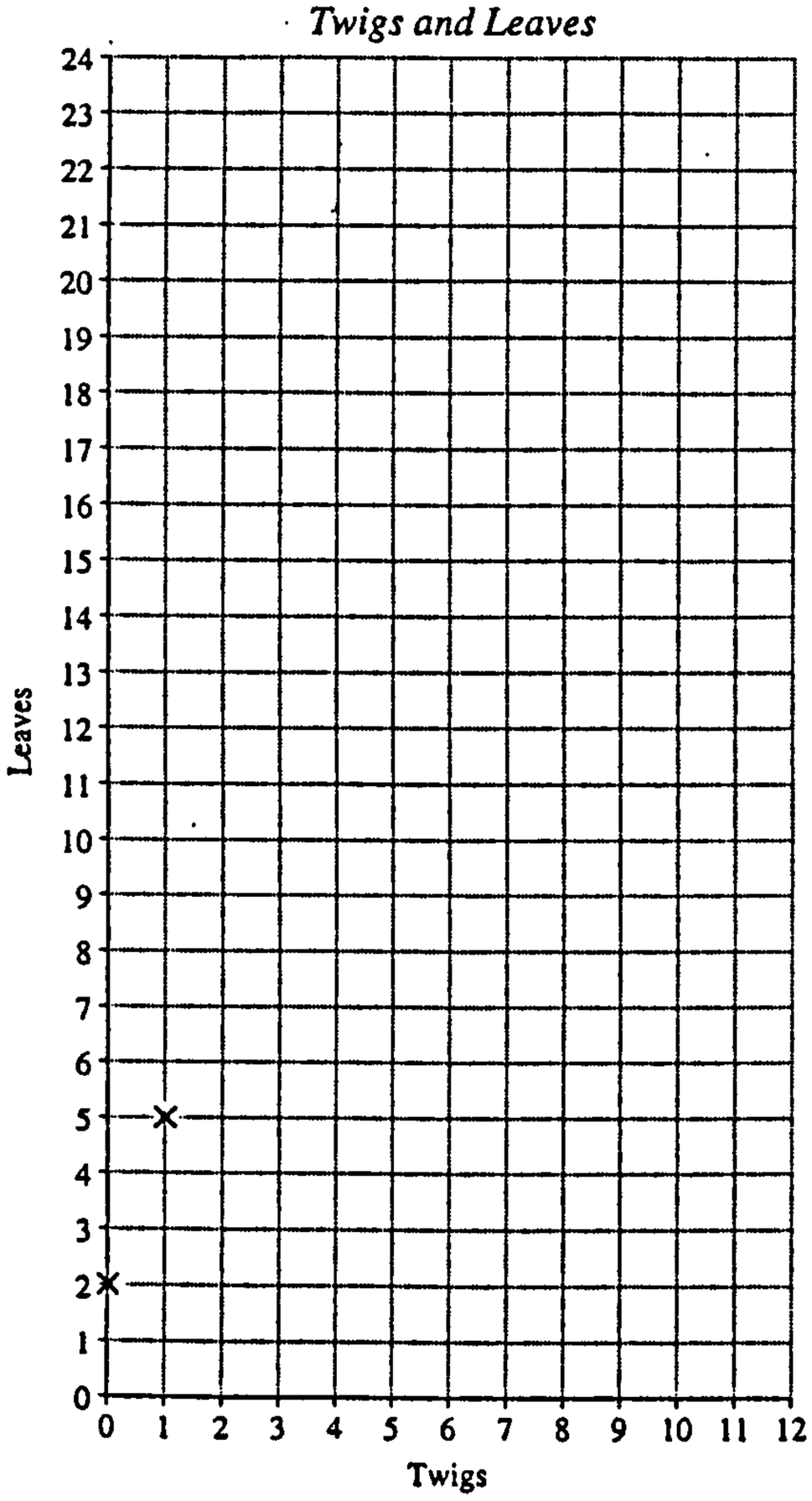
(b) What is different?

7 Two-step relation

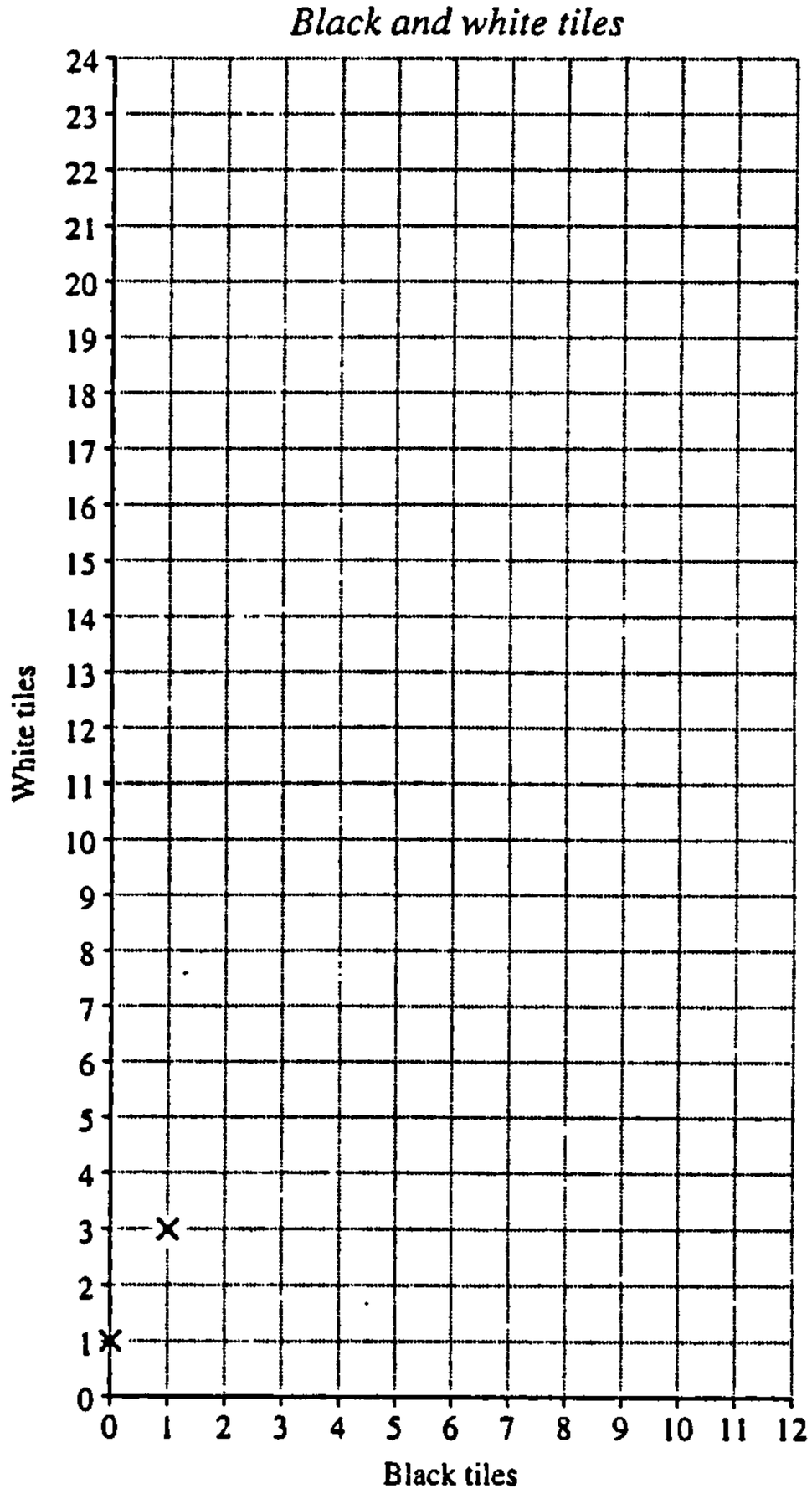
Notesheet 3

Graphs

1 Plot the number pairs from your twigs and leaves table. The first two are done for you.



2 Plot the number pairs from your black and white tiles table.



3 Describe the pattern of the twigs and leaves graph.

4 Describe the pattern of the black and white tiles graph.

5 What is similar about the two patterns?

6 What is different about the two patterns?

7 Which of the three methods of showing the patterns do you like best.

words and symbols, tables, graphs?

Explain why.

APPENDIX: F

GUIDELINES FOR TEACHER REFLECTION (FIRST DRAFT)

Guidelines for Teacher Reflection (First Edition)

Issues to reflect upon prior to lessons

- What do I have to consider in facilitating the lesson delivery?
  - Materials, space, classroom arrangement
- Are there any conditions that may affect the lesson outcome?
  - Ability range, etc.
- Am I sufficiently prepared for the lesson?
  - Do I need to assistance from any of my colleagues?
  - Is there anything special about this class that I must consider? (individual students, number in class, etc.)
- What provisions do I have to make for the differing abilities that exist?
- Do I have sufficient scheduled time to complete the lesson?

Issues to reflect upon during lessons

- Is the lesson going as planned?
- Are there any unforeseen developments to consider?
- Do students possess the necessary pre-requisite (previous knowledge)?
- Are students receptive to the activities? (How can I further capture their interest)?
- Do I have to make any adjustments?
- Are the adjustments effective? If not, what else can I do?

Issues to reflect upon after lessons

- How did the lesson go?
  - ♦ What are my general feelings about its delivery?
  - ♦ Were my questioning strategies effective?
    - Did I allow sufficient wait time?
    - Did I allow students to justify their responses?

- Did I allow them to build on the responses of others?
- Did I use probes effectively?

- Did I talk too much?
- Did I adequately challenge students?
- How was my tone of voice? (exciting, eager, positive, indifferent, negative, impatient, inconsistent based on individuals)

- What are my own thoughts about the topic?
- What are the potential areas for improvement?
- What are my thoughts on the class? (On individual students?)
- What unique incidents or interesting classroom developments occurred during the lesson?
- Did students gain anything from this lesson? How do I know? Could they have gained more?
- Did I learn anything from this session?
- How can I improve on the next lesson?
- How do these relate to my other lessons on the subject?
- How do they relate to my other lessons in general?

APPENDIX: G

GUIDELINES FOR TEACHER REFLECTION (FINAL COPY)

Guidelines for Teacher Reflection (Revised Edition)

Issues to reflect upon prior to lessons

- What do I have to consider in facilitating lesson delivery?
  - Materials, space, classroom arrangement
- What classroom conditions may affect the lesson outcome?
  - Ability range, etc.
- Am I sufficiently prepared for the lesson?
  - Do I need to contact any of my colleagues?
  - Is there anything special about this class that I must consider? (Individual students, number in class, etc.)
- What provisions do I have to make for the differing abilities that exist?
- Do I have sufficient scheduled time to complete the lesson?

Issues to reflect upon during lessons

- Is the lesson going as planned?
- Do I have students' constant attention?
- Am I doing too much teaching and too little facilitating?
- Are there any unforeseen developments to consider?
- Do students possess the necessary pre-requisite (previous knowledge)?
- Are students receptive to the activities? (How can I further capture their interest)?
- Do I have to make any adjustments? Should I attempt to teach it in a different way?
- Are the adjustments effective? If not, what else can I do?

Issues to reflect upon after lessons

- What did I set out to teach?
- Did I accomplish my objective(s)?
- How did the lesson go?

- Did I prepare sufficiently?
- What are my general feelings about its delivery?
- Was my teaching technique effective? Why? Why not?
- Were my questioning strategies effective?
  - Did I allow sufficient wait time?
  - Did I allow students to justify their responses?
  - Did I allow them to build on the responses of others?
  - Did I use probes effectively?
- Were my grouping arrangements effective? Why? Why not?
- Did I talk too much?
- Did I adequately challenge students?
- What did they enjoy most about it?
- What didn't they respond to well?
- Did every child learn something from this lesson?
  - How was my tone of voice? (exciting, eager, positive, indifferent, negative, impatient, inconsistent based on individuals)

- What problems did I experience during lesson delivery?
- Did I stray from the original lesson plan? If so, why?
- What are my own thoughts about the topic?
- What are the potential areas for improvement?
- What are my thoughts on the class? (On individual students?)
- What unique incidents or interesting classroom developments occurred during the lesson?
- Did the class gain anything from this lesson? How do I know? Could they have gained more?
- What was the main accomplishment of the lesson?
  - What parts were most successful?
  - What parts were least successful?

- Did I learn anything from this session?
- Would I have taught this lesson differently if I had to do it all over? Why? Why not?
- What would be a suitable follow up activity?
- How can I improve on the next lesson?
- How do these relate to my other lessons on the subject? How do they relate to my other lessons in general?

APPENDIX: H

PRE-INTERVENTION INTERVIEW SCHEDULE (FIRST DRAFT)

Pre-intervention interview schedule (first draft)

1. How do you believe Mathematics should be taught and learnt?
2. How would you describe your typical (normal) Mathematics lessons?
3. Besides the approach that you just mentioned, what other approaches do you use/
4. How do you cater for students with different abilities in your normal lessons?
5. (a)What are your impressions on:
    - Small-group activities
    - Whole class teaching
    - Lessons that challenge students to provide diverse responses

   (b) How comfortable are you with each of the methods just mentioned?
6. Do you believe that students are sufficiently challenged in your Mathematics classroom? Why? Why not?
7. What are your opinions on reflective teaching?
8. How does reflection relate to your daily practice?
9. How would you describe the level of collaboration among your colleagues in terms of sharing classroom experiences and teaching strategies?
10. How would you characterise students' classroom behaviour during your normal lessons in terms of their:
    - Level of interaction
    - Length and quality of responses
    - Contribution during lessons
    - Thinking about the contents of the lesson
    - Challenging others' responses to questions
    - The number of questions asked during lessons

APPENDIX: I

PRE-INTERVENTION INTERVIEW SCHEDULE (FINAL COPY)

Pre-intervention interview schedule (final copy)

1. How would you describe your mathematics lessons?
2. (a) Would you consider this the ideal instructional method? Why?

   (b) If not, then why not? What is you ideal method?
3. Besides the approach that you just mentioned, what other approaches do you use?
4. How do you cater for students with different abilities in your normal lesson?
5. (a). What are your impressions on:
   - Small-group activities
   - Whole class teaching

   (b). How comfortable are you with each of the methods we just discussed?
6. Do you believe that students are sufficiently challenged in your Mathematics classroom? Why or Why not?
7. (a) Do you think your Maths teaching improves with practice?

   (b) If yes, then how?

   (c) If no, then why not?
8. Tell me about the occasions where you take opportunities to sit back and think of the successes or limitations of past lessons.
9. How do you make use of opportunities where you might be able to share classroom experiences and teaching strategies with your colleagues?
10. How would you characterise students' classroom behaviour in terms of their:
    - level of interaction
    - length and quality of responses to questions
    - thinking about the contents of the lesson
    - challenging others responses to questions
    - number of questions asked during lessons

APPENDIX: J

POST-INTERVENTION INTERVIEW SCHDULE (FIRST DRAFT)

Post-intervention interview schedule (first draft)

1. How would you describe your normal (typical) mathematics lessons?

2. How would you describe the CAME lessons that you did in the past year?

3. Do you have any changes in beliefs on the teaching and learning of mathematics?

4. Were there any changes in the way that you catered for students with diverse abilities?

5. (a) Are there any changes in your beliefs on the following issues?

   - Whole-class teaching
   - Small group activities
   - Lessons that challenge students to provide diverse responses

   (b) How comfortable are you now with these methods?

   (c) Which did you use most often in the past year? Why?

6. (a) What are your opinions on reflective teaching?

   (b) How do these relate to your opinions a year ago?

7. Were there any changes in the level of collaboration among your colleagues during the year? Why? Why not?

8. How would you characterise students' classroom behaviour during your mathematics lessons in the past year, in terms of their:

   - level of interaction
   - length and quality of responses to questions
   - contribution during lessons
   - thinking about the contents of the lesson
   - challenging others responses to questions
   - number of questions asked during lessons

APPENDIX: K

POST-INTERVENTION INTERVIEW SCHEDULE (FINAL COPY)

Post-intervention interview schedule (final copy)

1. How would you describe the normal mathematic lessons?
2. How would you describe the CAME lessons that you did in the past months?
3. Were there any changes in your beliefs on the teaching and learning of mathematics?
4. Were there any changes in your practice?
5. Were there any changes in the way that you catered for students with diverse abilities?
6. (a) Were there any changes in your beliefs on the following issues?
   - Whole-class teaching
   - Small group activities

   (b) Which did you use most often in the past year? Why?
7. (a) What are your opinions on reflective teaching?

   (b) How do these relate to your opinions a year ago?

8 Were there any changes in the level of collaboration among your colleagues during the year? Why? Why not?

9 . How would you characterise students' classroom behaviour during your mathematics lessons in the past year, in terms of their:

- level of interaction
- length and quality of responses to questions
- contribution during lessons
- thinking about the contents of the lesson
- challenging others responses to questions
- number of questions asked during lessons

APPENDIX: L

OBSERVATION CHECKLIST (FIRST DRAFT)

Observation Checklist (first draft)

School code _____

Subject _____

Teacher code _____

Class level _____

Age range_____

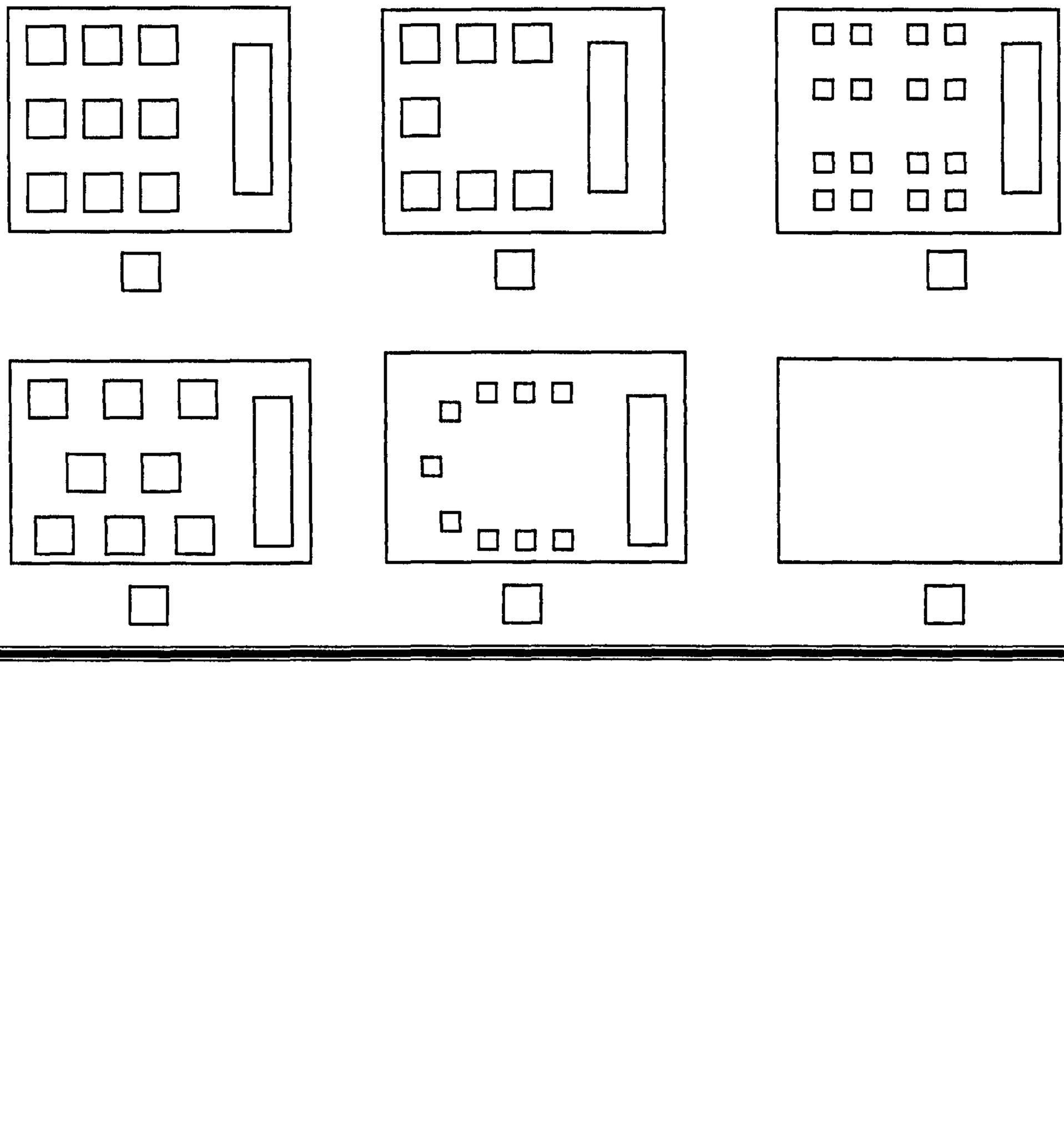
Duration _____

Class size_____

Date _____

Time _____

Tick the appropriate class setting:



DESCRIPTION	OCCURRENCES (FREQUENCY)
Open ended questions	
Closed questions	
Instances of probing for reasons	
Praise students' responses	
Initiate small-group discussion/activity	
Initiate individual activity	

Other areas for observation. Please tick as appropriate after lesson delivery

5	4	3	2	1
VERY GOOD	GOOD	AVERAGE	BAD	POOR

DESCRIPTION	5	4	3	2	1
Use of materials					
Introduction					
Conclusion/summary					
Transfer of learning (bridging)					
Use of realistic examples during explanation					
Distribution of questions among class					
Task explanation					
Use of diverse problem-solving strategies					

APPENDIX M

DESCRIPTION OF TEACHER RELATED FEATURES FOR OBSERVATION

Description of teacher-related features

(Definition of terms used in the structured observation checklist)

Open-ended question:	Questions that encourage divergent responses or those where there may be a number of credible responses.
Closed responses:	Questions to which there is only one, usually brief, correct response.
Probe responses:	Encouraging students to respond with greater depth and clarity though a series of investigative questions.
Praise students' responses:	Complimenting students for appropriate responses to questions or other class activities.
Challenge students' responses:	Encouraging students to provide in-depth responses through the use of thought provoking questions.
Build on students' responses:	Supplementing students' responses usually with additional information relating to the given response.
Small group activity:	Allowing students to work together with a limited number of partners, usually between three and six individuals.

Terms used in descriptive aspects of lesson observation

Use of materials:	Appropriate use of teaching aids during lesson delivery. This includes all forms of stimuli that will aid student learning.
Lesson introduction:	The art of obtaining and maintaining students' attention and interest during the opening moments of a lesson.
Lesson conclusion:	One's ability to end a lesson in a strong and effective manner that will facilitate student retention.
Opportunities for transfer of learning:	The provision of practical examples and realistic opportunities for student s to demonstrate the concepts learnt.
Realistic examples during explanation:	The teacher's ability to use relevant, genuine and authentic examples during classroom instruction.
Distribution of questions among class:	Ensuring that questions are equitably distributed among students in the classroom in a manner that will encourage responses from as many students as possible.
Task explanation:	The provision of clear and simple descriptions, interpretations or illustrations to ensure that students are able to undertake a given task without undue difficulty.
Use of diverse problem-solving strategies:	Encouraging students to use a variety of methods to solve a problem, usually in a discovery setting.

APPENDIX: N

OBSERVATION CHECKLIST (FINAL COPY)

Observation checklist (final copy)

School code _____ Subject _____

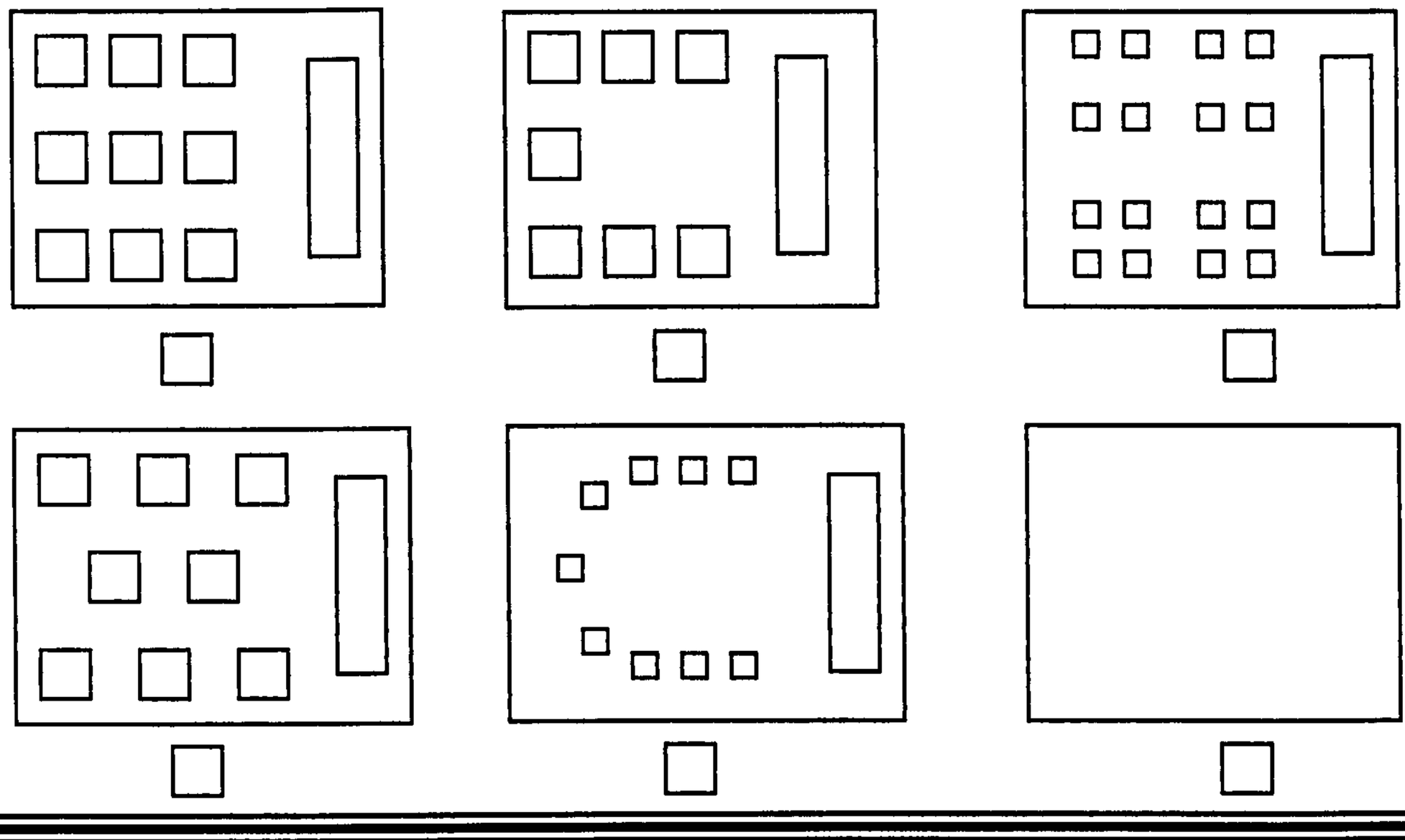
Teacher code _____ Class level _____

Age range_____ Duration _____

Class size_____ Date _____

Time _____

Tick the appropriate class setting:



DESCRIPTION	OCCURRENCES (FREQUENCY)	
	TALLY	TOTAL
Open ended questions		
Closed questions		
Probe responses		
Praise responses		
Challenge students' responses		
Build on students' responses		
Small group activity		

Other areas for observation. Please tick as appropriate after lesson delivery

3	2	1
GOOD	AVERAGE	NEEDS IMPROVEMENT

DESCRIPTION	3	2	1
Use of materials			
Lesson introduction			
Lesson conclusion/summary			
Opportunities for transfer of learning (bridging)			
Use of realistic examples during explanation			
Distribution of questions among class			
Task explanation			
Use of diverse problem-solving strategies			

APPENDIX: O

LETTER SEEKING PERMISSION FROM MINISTRY OF EDUCATION FOR RESEARCH PURPOSES

C/o Learning Support Unit
Education Science and Technology Building
Ministry of Education

The Chief Education Officer
Government Headquarters
Kennedy Avenue
Roseau
03/09/02

Dear Sir:

As a component of my university degree programme, I am required to conduct elaborate research relating to my field of study. Currently, I am conducting a research study on the impact of teaching thinking skills on teachers' pedagogy and professional development.

In this regard, I wish to request permission to conduct practical research activities at three secondary schools in Dominica during the academic year September 2001 to August 2002. During this period, I will be visiting schools for the purpose of in-service training and support, lesson observation and teacher interviews.

In addition to personal benefits form this research, I am sure that it will be of immense benefit to the schools under study. Please find attached a copy of the schools that I intend to use for the research study.

I wish to express my gratitude for your anticipated assistance and in allowing me access to the schools in question and for your invaluable contribution to the development of education in Dominica.

Respectfully,

.....

JEFFREY BLAIZE

APPENDIX: P

LETTERS SEEKING SCHOOLS' PERMISSION FOR RESEARCH

C/o Learning Support Unit
Education Science and Technology Building
Ministry of Education

12/09/02

Dear Madam:

As a component of my university degree programme, I am required to conduct elaborate research relating to my field of study. Currently, I am conducting a research study on the impact of teaching thinking skills on teachers' pedagogy and professional development.

In this regard, I wish to request permission to conduct practical research activities at your school during the academic year September 2001 to August 2002. During this period, I will be visiting the school for the purpose of in-service teacher training and support, lesson observation and teacher interviews.

In addition to personal benefits form this research, I am sure that it will be of immense value to your school, as well as for the continued development of education in Dominica. Please be informed that I have already informed the Ministry of Education about this exercise.

I wish to express my gratitude for allowing me access to your school and for your direct contribution towards the improvement of education in Dominica.

Respectfully,

JEFFREY BLAIZE

APPENDIX: Q

WORKSHOP EVALUATION SCRIPTS

SCHOOL: A

Number of participants: 6

Key:

1	0	2
Lowest score	**Not sure**	**Highest score**

STATEMENTS	RATINGS								
	WORKSHOP 1			**WORKSHOP 2**			**WORKSHOP 3**		
	1	**0**	**2**	**1**	**0**	**2**	**1**	**0**	**2**
The quality of presentations	-	-	6	-	-	6	-	-	6
The content discussed	-	-	6	-	-	6	-	-	6
The practicality of strategies discussed	-	-	6	-	-	6	-	1	5
The level of engagement required	-	1	5	-	1	5	-	-	6
Facilitator's familiarity with contents	-	-	6	-	-	6	-	-	6
Facilitator's appreciation of teaching context	-	1	5	-	1	5	-	1	5

QUESTIONS	TEACHERS' COMMENTS		
	Workshop 1	*Workshop 2*	*Workshop 3*
1. What were the strong points of the session?	*Everything discussed was related to the topic, kept participants totally engaged, the humour came in handy and made points more effective, the group activities, practical examples, relevance of the issues.*	*The humour during sessions, hands-on activities, knowledge of topic, ability to keep interest of participants, refreshing content, contemporary theories, exciting group discussion.*	*The excitement during delivery, the new ideas presented, practical examples, presenter's knowledge of content, the fun during the session.*
2. What could have been changed?	*Nothing, session was ok, more examples, more time for session.*	*More specific information, nothing, good session.*	*Added time for group discussion, some practice in actually constructing the teaching aids, nothing, great session.*
3. What areas would you like explored in future sessions?	*Time management, teaching group activities, generating student interest, questioning approaches, challenging students, lesson planning, assessing thinking skills lessons.*	*Assessment, time management, managing conflicts during group work, lesson planning, teaching students to work in groups.*	*Managing time during teaching, the different aspects of a lesson plan, developing tests related to thinking, encouraging student motivation, challenging students, managing group work.*
4. Your reflections...	*The approach has the potential to be time consuming, good sessions, activities will be rather helpful to my teaching, this is an interesting approach to teaching, need more training to be really effective in this approach.*	*The session was relevant and useful, time used wisely, very exciting ideas, practical strategies for student learning, interesting session.*	*Great presentation, more sessions needed of this nature, practical stuff, stimulating exercises which will make a teacher think differently.*

SCHOOL: M Number of participants: 3

Key:

1	0	2
Low score	**Not sure**	**High score**

STATEMENTS	RATINGS								
	WORKSHOP 1			WORKSHOP 2			WORKSHOP 3		
	1	0	2	1	0	2	1	0	2
The quality of presentations	-	-	3	-	-	3	-	-	3
The content discussed	-	-	3	-	-	3	-	-	3
The practicality of strategies discussed	-	-	3	-	-	3	-	-	3
The level of engagement required	-	1	2	-	-	3	-	-	3
Facilitator's familiarity with contents	-	-	3	-	-	3	-	-	3
Facilitator's appreciation of teaching context	-	1	2	-	1	2	-	-	3

QUESTIONS	TEACHERS' COMMENTS		
	Workshop 1	*Workshop 2*	*Workshop 3*
1. What were the strong points of the session?	*The level of engagement, the interest displayed by the presenter, the new ideas, practicality of session, the down-to earth method of presentation, group discussions, clarity during presentations, teamwork.*	*Hands-on activities, presenter's awareness, engaging presentation, level of group discussion, practical examples, laughter, practical materials, variety*	*Effectiveness of presentation, the facts presented, laughter, new ideas, variety, group work, time management, the questioning strategies.*
2. What could have been changed?	*Session was too short, nothing really, more time for discussion, more practice with thinking lessons.*	*More time to practice thinking lessons, longer sessions, nothing could have been improved, good session.*	*The variety in examples, more exercises of this nature, not enough time to complete the activities.*
3. What areas would you like explored in future sessions?	*How to challenge students even more, group work, activities that can be used in the classroom, maths strategies, generating interest in the classroom, developing different types of tests.*	*Techniques for material production, lesson planning, time management, challenging students more, effective grouping.*	*Different instructional styles, planning lessons, managing students' learning, motivating students, coping with misbehaving students.*
4. Your reflections...	*Sessions was good but the strategy appears time consuming, planning these lessons might require lots of time and effort on the part of the teacher, was rather impressed by the sessions, the sessions were useful to me as a teacher, need more sessions like these.*	*Enjoyed the presentations, need sessions on making materials for teaching Mathematics, the ideas were interesting but will require a radical shift in the education system, teachers need many more sessions like these in the absence of formal teacher training.*	*Timely presentations, great stuff needed that long ago, sessions were interesting but might be difficult to implement, lots of things need to be changed in the system to ensure success with such an approach.*

EVALUATION OF WORKSHOPS BY SCHOOLS

SCHOOL: **C** Number of participants: **10**

Key:

1	0	2
Low score	**Not sure**	**High score**

	RATINGS								
STATEMENTS	**WORKSHOP 1**			**WORKSHOP 2**			**WORKSHOP 3**		
	1	**0**	**2**	**1**	**0**	**2**	**1**	**0**	**2**
The quality of presentations	-	-	10	-	1	9	-	3	7
The content discussed	-	-	10	-	-	10	-	-	10
The practicality of strategies discussed	-	1	9	-	-	10	-	1	9
The level of engagement required	-	1	9	-	2	8	-	-	10
Facilitator's familiarity with contents	-	-	10	-	-	10	-	-	10
Facilitator's appreciation of teaching context	-	1	9	-	2	8	-	1	9

QUESTIONS	TEACHERS' COMMENTS		
	Workshop 1	*Workshop 2*	*Workshop 3*
1. What were the strong points of the session?	*Enthusiasm of presenter, hands-on approach, group discussion, knowledge of the topic, ability to keep interest of teachers, new idea and challenge, refreshing content, variety, interaction with all teachers, everything,*	*Session well-presented, no loss of time, practical examples, use of practical examples, humour during presentation, the level of authority, surprising facts, exposure to current theories in education, illustrations, reinforcement of concepts already acquired, good examples,*	*Level of preparedness, clarity of thought and expression, engagement of group, relevance of issues, use of proper questioning techniques, presentation was well done, was quite straightforward, very energetic presentation, quite knowledgeable on subject matter, thorough explanation given, practicality*
2. What could have been changed?	*More time devoted to each aspect, too short, nothing really, even more practical examples of all major points, more time for group activities.*	*Additional visual materials, nothing, sessions were perfect, more specific information, more suggestions for implementation of ideas, more time allowed for group work, timing of the session.*	*More participation on the part of listeners, more practical, a more appropriate timely day for session, more time for the session, nothing, session was good.*
3. What areas would you like explored in future sessions?	*Use of effective teaching time as a tool for effectiveness, thinking sessions to help teachers, working with students in groups, time management in the classroom, development of lessons, managing activities, questioning, Mathematics teaching, material designing, strategies for expanding cognitive development.*	*More actual examples of practical activities, methods of putting ideas into practice, classroom management, strategies for working more cognitive type reasoning into a system where such instructional style has become the norm, examples in other subjects, whatever else is available.*	*The effective use of classroom time, development of lessons, questioning strategies, group-work in the classroom, dealing with de-motivated learners, managing classroom time, keeping students interest.*
4. Your reflections...	*Very good presentation, the workshop has given me much to think about as well new ideas, informative session, thanks! That was good, it opened my eyes to many errors in teaching, food for thought, useful information, absolutely enlightening, good teacher, knowledgeable.*	*Comfortable to talk to, understanding, effective, managed time well, enthusiastic, refreshing, wonderful session, well-researched, organised and relevant, well done, will help a great deal in future classes, very good presentation.*	*It was stimulating, presenter was comfortable with delivery in subject area, excellent presentation, a refresher course, a practical approach, good session, the ice-breaker was very appropriate, extensive research done, excellent presentation, great familiarity with topic.*

APPENDIX: R

SCRIPTS FROM THE RESEARCHER'S FIELD NOTES

Schedule for practical research activity

School A		
Activity	**Term**	**Planned Dates**
Pre-intervention interviews and lesson observation. Training workshop on the development of thinking skills in students and on journal writing. Delivery of pilot thinking lessons before full implementation.	1	17/09/01; 24/09/01 01/10/01; 15/10/01 29/10/01; 05/11/01 12/11/01; 19/11/01
Lesson observation and in-service support. Focus group discussion and informal rapport with various teachers.	2	14/01/02; 21/01/02 28/01/02; 04/02/02 18/02/02; 25/02/02
Observation with minimal support. Post intervention interviews (individual teachers) and observations. Collection of journals of reflection.	3	15/04/02; 22/04/02 06/05/02; 13/05/02 03/06/02; 10/06/02

School M		
Activity	**Term**	**Planned Dates**
Pre-intervention interviews and lesson observation. Training workshop on the development of thinking skills in students and on journal writing. Delivery of pilot thinking lessons before full implementation.	1	18/09/01; 25/09/01 02/10/01; 16/10/01 30/10/01; 06/11/01 13/11/01; 20/11/01
Lesson observation and in-service support. Focus group discussion and informal rapport with various teachers.	2	15/01/02; 22/01/02 29/01/02; 05/02/02 19/02/02; 26/02/02
Observation with minimal support. Post intervention interviews and observations. Collection of journals of reflection.	3	16/04/02; 23/04/02 07/05/02; 14/05/02 04/06/02; 11/06/02

School C		
Activity	**Term**	**Planned Dates**
Pre-intervention interviews and lesson observation. Training workshop on the development of thinking skills in students and on journal writing. Delivery of pilot thinking lessons before full implementation.	1	19/09/01; 26/09/01 03/10/01; 17/10/01 31/10/01; 07/11/01 14/11/01; 21/11/01
Lesson observation and in-service support. Focus group discussion and informal rapport with various teachers.	2	16/01/02; 23/01/02 30/01/02; 06/02/02 20/02/02; 27/02/02
Observation with minimal support. Post intervention interviews and observations. Collection of journals of reflection.	3	17/04/02; 24/04/02 08/05/02; 15/05/02 05/06/02; 12/06/02

THE RESEARCHER'S DIARY ENTRIES (FIELD NOTES, SCHOOL A)

17/09/01:

The aim of this visit was to discuss plans for the practical research activity at the school. Both the principal and Head of Department appeared enthusiastic about the prospects for conducting research of this nature at the school. The principal mentioned problems with adequate training of teachers and felt that the training and support would greatly benefit her staff. She indicated that the teaching of thinking would be very appropriate particularly for the teachers with remedial students. The Head of Department and principal agreed to begin the research as soon as possible and a further meeting was planned for 24/09/01 where the research study would be discussed with teachers.

24/09/01

The visit was designed to inform teachers about the research activity at the school. Six Mathematics teachers including the Head of Department were present. The principal was not at this meeting. Teachers were briefed on the purpose of the research and the phases of the practical research activity. All teachers appeared enthusiastic. However, some appeared uneasy about the prospect of classroom observations. They were re-assured that the approach was not designed to be a teacher evaluation exercise but rather a teacher support initiative. Teachers also had concerns about the added workload.

Teachers agreed to begin the pre-intervention data collection within one week and the following dates were planned for observation and interview: 01/10/01; 15/10/01; 29/10/01. Teachers were informed of my need to get used to the classroom setting so as to minimise unintended student reactions during the data gathering exercise. Hence, two casual observation sessions were agreed upon for the following week with each of the Mathematics teachers. It was decided that during this period data would not be collected for research purposes.

01/10/01:

Pre-intervention lesson observation began today. A total of six teachers were observed in action. Each observation lasted 40 minutes and there was an additional observer so as to validate observation results. Observations comprised two components namely a structured section and a descriptive aspect, where teachers were rated based on their performance. Initially, many of the teachers appeared uneasy with the presence of other adults in their classroom but they eventually felt more comfortable as the lessons progressed.

On a surface level, it was discovered that all teachers utilised a traditional teaching format where children were seated in distinct rows, often completing exercises from a text after a short period of explanation from the teacher. At the end of the initial observation sessions, all teachers agreed to a follow up observation session within one week.

15/10/01

The observations continued today with a total of six lesson observations altogether. There was also an extended rapport with the Head of Department. He was of the opinion that inexperienced teachers desperately needed assistance and support. He also expressed concern relating to teaching aids and classroom space. The issue of classroom space was also addressed during a brief meeting with the principal. She indicated that she was in the process of putting together a proposal for an annex to the existing school building to house some of the students since classrooms are too crowded and might be in need of my assistance in putting a case forward. The principal and Head of Department were informed that the next sessions would be teacher interviews and as such added time would be required since teachers were to be interviewed on an individual basis.

Teachers were met at the end of regular sessions to decide times for individual interviews. Since teachers were reluctant to remain at school after regular hours, it was decided that interviews would be conducted during school hours on teachers 'free' periods.

29/10/01

Pre-intervention interviews began today. Six teachers were individually interviewed during their free periods. From teachers' responses, it was discovered that the inexperienced teachers had some reservations about trying new ideas. Based on the responses given by untrained and particularly new teachers, it appeared that their lack of experience affected their confidence. These teachers often felt that they already had too much to do in too little time and they were not confident enough in existing methods to try new approaches. Experienced teachers appeared more supportive of the initiative and appeared eager to see what constituted the teaching of thinking. The first workshop was scheduled for 05/11/01.

Reminder: Prepare workshop materials for next session.

05/11/01

The first workshop was held today. The workshop was conducted at the school and teachers were required to return to school for the session. The workshop highlighted the importance of teaching thinking, the use of challenge in the classroom, questioning strategies and managing group activities. Teachers appeared to have benefited from the session.

One of the problems that teachers raised was the fact that some had problems returning to school for the workshop. Instead, teachers wanted to have the workshop immediately after dismissing students for their lunch break. Since regular sessions end at 1:00pm it was agreed that the next session would begin at this time. A workshop evaluation form was distributed and a quick view of the responses suggested a high degree of satisfaction on the part of teachers. A more detailed observation of the evaluation forms was planned for a later date. The next workshop was scheduled for 12/11/01.

12/11/01

This session was held immediately after student dismissal so as to meet teachers' needs. It was slightly shorter in duration than the previous workshop. The session was well attended. Teachers were also shown samples of Thinking Maths lessons in the form of a demonstration. They were keen on the concept of teaching thinking. There was a review of the issues discussed in the past week's session and teachers were given some time to ask questions. Many were concerned with methods of incorporating the teaching of thinking in their regular lessons. Hence, they were informed that we would do a series of Thinking Maths lessons together so they would have an idea of how thinking is infused into the subject of Mathematics.

There were a number of practical exercises during the workshop. The areas of teachers' professional development and reflection on practice were addressed. Teachers were given materials to create their own journals for reflection. A guideline for journal entries was also provided but teachers were reminded that they did not necessarily have to follow this guideline. Another workshop evaluation form was distributed towards the end of the workshop and the next session was planned for 19/11/01.

Reminder: *Copy thinking lessons and prepare lesson materials for teachers*

19/11/01

Due to upcoming school exams this was the last session for the school term and it was intended to address the issue of thinking lessons. In order to give teachers more practice in the delivery of thinking lessons, they were placed into pairs and each pair was assisted in the preparation and delivery of a Thinking Maths lesson. The other teachers were then allowed to provide feedback based on the presentation. The presentations went well and teachers enjoyed the activity. An evaluation sheet was not distributed for this session. However, a verbal evaluation was conducted and it appeared that the teachers enjoyed the workshop. Since this was the last meeting for the term, teachers were given a series of thinking lessons that they were to review during the vacation period. After the workshop, an informal meeting was held with the principal and Head of Department where plans were made for the next terms activities. It was decided that the research work would continue from 14/01/02.

07/01/02

Initial conclusions based on pre-intervention data

There were only two formally trained and experienced staff members at the Mathematics Department. The staff members were rather co-operative and the HOD was instrumental in advocating an exploration of the approach. The new members of staff shared some degree of enthusiasm but this was influenced by routine school activities that they had to perform, since they had not yet come to grips with their workload.

Pre-intervention data collection went smoothly and both students and teachers got used to my presence at the school. Many of the teachers were satisfied with the degree of training provided prior to implementation. Their content was reflected in comments made on the workshop evaluation scripts. Initial interviews seem to indicate that there is a difference between teachers in terms of their beliefs. Three of the six teachers appear to hold progressive beliefs, while the other three held traditional beliefs. A review of teacher status reflected that two of the three teachers with progressive beliefs were formally trained and experienced, while all of the teachers with traditional beliefs were untrained and inexperienced.

Untrained teachers seem to hold the view that a traditional conception of teaching and learning is all that they know. Teachers generally used a whole class approach to instruction. They claimed that their preference for whole class teaching was related to the following reasons:

There were fewer classroom management problems with the whole class teaching approach as opposed to small group activity.

Whole class teaching is the only method with which they are truly comfortable

The use of whole class teaching meant that the curriculum was completed in a shorter space of time.

Students often use small group activity as an excuse to play.

Individual performance cannot be assessed through small group activity.

Small group activity means more work for the teacher in terms of organisation and planning.

Students don't always like working in groups.

The teachers generally felt that the education system needs to be changed to facilitate the use of any new teaching approaches. Trained teachers believed issues such as time constraints, availability of resources, curriculum pressures and assessment frameworks need to be addressed. Untrained teachers, on the other hand, believed the primary change in the education system should be the pre-service training of teachers since they should have been formally trained before entering the classroom.

Most teachers defended their limited use of learning aids with the argument that it is not possible to leave mobiles and other learning resources in the classroom since the room is often utilised for various subjects. This means that since the teacher does not have a permanent room for teaching, materials would be quickly destroyed if left in the classroom.

An initial analysis of pre-intervention lesson observation seems to conclude that all teachers utilised traditional classroom practices irrespective of their beliefs. They all used a whole class teaching approach. In addition, they rarely used features such as open-ended questions, probing or even praise to students' responses. Small group activity was not a feature of any of the lessons observed.

An initial assessment appear to indicate that teachers had a range of traditional and progressive approaches but they all engaged in traditional classroom practices.

14/01/02

This was the first session for term two. Inexperienced teachers were still sceptical about the idea of trying out something totally new in the classroom. Upon informal rapport with some of the inexperienced teachers, it was discovered that they felt that they were not competent enough in their current practices to the point of trying out new approaches. They were reassured that continuous support would be provided throughout the process.

One of the main concerns of teachers was the potential influence of the Thinking Lessons on curriculum contents in terms of the adequacy of coverage. Many were of the view that some of the topics would not be adequately covered because of the amount of time that thinking lessons would take. They were informed that most of the lessons were related to topics in the school curriculum and therefore curriculum scope would be unaffected. Further, they were told that the lessons should only be done once every two weeks and further these could be modified to suit their classroom context in terms of students' ability. Teachers were given some of the materials that they would need for lesson delivery including photocopies of relevant activity sheets.

21/01/02

Lesson observation resumed today. These were to asses teachers' practices during the active intervention period. Observations dates were announced prior to today's visit so teachers were well aware of the visit. Prior to this observation session, teachers were asked to prepare the same topic and lesson objective so as to minimise differences during lessons delivery that could be based on the degree of interest and practicality of the lesson.

A total of six observations were made, each lasting forty minutes. An additional observer was present so as to validate observation results. The observations were made up of a structured component and a descriptive aspect. In the descriptive aspect, a scale was used to measure teachers' performances. At the end of each observation session, evaluative discussions were held with the relevant teachers so as to get their direct perceptions on the lesson outcome. Teachers were reminded that they should make the relevant entries in their journals.

28/01/02

This session comprised a focus group discussion. It was intended to get teachers' impressions on the first thinking Maths lesson delivered and the problems that they might have experienced. During lesson observation it was discovered that none of the teachers managed to complete their lessons within the given time period. Teachers indicated that there were too many activities and as such lessons could not be completed within the given timeframe. Teachers were generally dissatisfied with students' performance during the lessons, particularly in their receptivity to small group activity. Teachers were informed that the development of effective work in small groups takes time and they should not expect grouping to work well for students in the first few lessons. Many teachers felt that the lessons required much more work than they normally did, particularly during planning and delivery phases.

02/02/02

On going analysis during the intervention phase

This phase of the research seems to be progressing smoothly. Lesson observations are on schedule. From an initial observation, it could be concluded that formally trained and experienced teachers appear to be making more of an effort to change practice. Untrained teachers appear to be progressing but they seem to have problems with lesson delivery. Some of the flaws in their lesson delivery could be attributed to a lack of teacher training. One of the major problems appears to be that of classroom management. The performance of teachers in terms of lesson delivery has prompted me to carry out demonstrative lessons with students in some classrooms so that teacher would have a first hand view of how actual thinking lessons are delivered.

Some teachers are keeping their journals up-to-date but there are others who seem to forget to make entries in a timely fashion.

04/02/02

Based on the results of the first thinking Maths lessons, it was decided that this session would be devoted towards in-service support for the teachers. Some of the issues that surfaced during the last session were addressed. In addition, demonstrative lessons were planned for 10/02/02; 11/02/02 and 12/02/02. Teachers with 'free periods' were encouraged to view the lessons. It was expected that teachers would observe the teaching strategies and students' reactions.

18/02/02

Lesson observations continued and it appeared that demonstrative lessons might have impacted one teachers' lesson delivery since teachers felt more comfortable in discussing lesson outcomes. Six lessons were observed. Some teachers felt that a lack of teacher training impacted on their effectiveness. Others felt that problems relating to classroom space, curriculum pressures and inadequacy of teaching materials affected their effectiveness. Teachers also felt that there was inadequate time to complete some of the lesson activities.

25/02/02

This was intended to be the final session for the school term. The information from journals was reviewed for a brief period. There was also a focus group meeting in order to ascertain teachers' perceptions on the research at this point of the study. From the general discussions, the following issues emerged:

Teachers concede that thinking lessons were beneficial but time consuming.

Teachers felt that there were factors beyond their control that impacted on the effectiveness of the approach.

There was an informal session with the school principal and HOD and plans were made for the final phase of the research in the coming term.

02/03/02

There was bereavement at the school due to a fatal incident and hence research work was suspended for one month.

Observation at the end of the intervention phase

Based on lesson observation during this phase, it was clear that there was some change in practice. All teachers made greater use of open-ended questions, probing and small group activity. There was also an increase in the use of praise to students. One interesting observation was the fact that there was no change in teachers' performances in task explanation and in the distribution of questions among students. Even during pre-intervention data collection, teachers demonstrated 'satisfactory performance' in these areas. An initial conclusion was that teachers' satisfactory performance in these areas might have been due to the fact that these are central features of whole class teaching, a method with which teachers appear comfortable. Many teachers kept their journals up-to-date. The following were the major issues which surfaced at the end of this phase of the research activity.

Untrained teachers generally had a change of view in terms of progressive approaches since all teachers viewed these approaches as beneficial.

All teachers had a change of view on small group activities since they conceded that this method worked well, particularly when the teacher had a clear objective in mind. However, they still maintained that it was difficult to assess individual performance through this method.

Teachers still maintained that progressive approaches were time consuming.

Teachers felt that problems with the education system impeded full implementation and constant use of the approach.

Teachers generally felt that they had a different focus during staff meetings because much of their discussion was centred on issues related to teaching and learning.

Teachers were keen on the use of activity sheets but felt that their lack of permanence meant that student performance could not be effectively tracked since students were not always very careful with these sheets.

Teachers were advised that they should store activity sheets in permanent files to be retrieved when needed. They were also encouraged to have activity sheets for individual students as much as possible so that individual performance could be assessed.

15/04/02

This was the first session of the school term. Teachers were informed that observations during this phase would be unannounced and that less support would be given during this period. Teachers were reminded that they should continue with the journal entries and they were given the necessary materials for delivery during this phase.

22/04/02

This was the first unannounced observation session. Six lessons were observed. There was evidence of effective questions approaches, praise to students and probing but minimal use of small group activity. In retrospect, there seemed to have been greater use of effective strategies last term as compared to the lessons observed. Teachers considered the time factor as a crucial element in determining the strategy that they used to teach on a regular basis. Some teachers felt that the teaching of thinking was too demanding due to the degree of work that was required during the normal school day.

06/05/02

The second observation session was held today. Each teacher received a forty-minute observation. Most teachers delivered thinking lessons but it appeared that some had been reserved for this lesson observation session. A fair degree of challenge was observed in many lessons and teachers practiced effective questioning techniques. However, there were limited opportunities for students to discover information on their own. On many occasions teachers still gave students formulas and a huge number of questions for practice.

13/05/02

Today was devoted to checking teachers' journals so as to ensure that entries were up-to-date. There were meetings with individual teachers to discuss the schedule for interviews in the coming weeks.

03/06/02

Post intervention interviews began today. Teachers were interviewed on a one-to-one basis. There were three interviewed during this session. The teachers generally felt that there was a change in beliefs. The untrained teachers interviewed felt that lack of training impacted on their use of the approach. Teachers also considered inadequacy of time as a major constraint.

10/06/02

This was the final session with this school. The remaining three teachers were interviewed and the journals were collected. There was a final focus group meeting with the teachers in order to obtain their collective perceptions on the innovation. From this discussion, the following issues emerged:

There was a general change of beliefs on the teaching and learning of Mathematics.

Time constraints and pressures to complete the curriculum affected teachers' ability to continue practicing the approach.

The education structure encouraged whole class teaching because of the examination system, lack of teacher training and inadequacy of materials.

The use of thinking lessons assists in learning but requires too much effort and time to be implemented on a regular basis.

Reflection on practice was useful for teacher improvement but more time was needed for reflection.

At the end of the group discussion, teachers were thanked for their participation. A meeting was then held with the school principal and Head of Department in which the general conclusions were discussed. The staff and principal were thanked for their support throughout the research period.

APPENDIX: S

SAMPLE OF RAW DATA FOR ONE TRAINED AND ONE UNTRAINED TEACHER UNDER STUDY

TEACHER OBSERVATION SCHEDULE (SECTION 1)

OBSERVATIONS TABULATED DURING A 40 MINUTE PERIOD

OCCURENCES (FREQUENCY)									
CODE	**PRE-INTERVENTION**			**INTERVENTION**			**POST-INTERVENTION**		
TEACHER INITIATED ACTIVITIES	Lesson 1	Lesson 2	Average	Lesson 1	Lesson 2	Average	Lesson 1	Lesson 2	Average
Open ended questions	4	5	**5**	5	6	**6**	4	5	**5**
Closed questions	12	10	**11**	13	11	**12**	8	11	**10**
Probe responses	3	5	**4**	3	3	**3**	4	7	**6**
Praise responses	2	2	**2**	6	3	**5**	3	3	**3**
Challenge students' responses	2	1	**2**	2	3	**3**	3	4	**4**
Build on students' responses	8	6	**7**	7	5	**6**	6	4	**5**
Small group activity	0	0	**0**	1	1	**1**	1	1	**1**

Structured observation results (Teacher 8MF of School M)

TEACHER OBSERVATION SCHEDULE (SECTION 2: Other areas for observation)

3	2	1
GOOD	AVERAGE	NEEDS IMPROVEMENT

DESCRIPTION	PRE INTERVENTION						INTERVENTION						POST INTERVENTION					
	LESSON 1			LESSON 2			LESSON 1			LESSON 2			LESSON 1			LESSON 2		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Use of materials		*		*				*			*		*					*
Introduction		*		*				*			*			*			*	
Conclusion/summary	*				*		*				*		*			*		
Transfer of learning (bridging)	*			*			*			*			*			*		
Use of realistic examples	*				*			*			*			*			*	
Distribution of questions among class		*			*		*				*			*			*	
Task explanation		*			*		*			*				*			*	
Diverse problem-solving strategies	*			*				*			*		*					*

Descriptive results (Teacher 8MF of School M)

TEACHER OBSERVATION SCHEDULE (SECTION 1)

OBSERVATIONS TABULATED DURING A 40 MINUTE PERIOD

OCCURENCES (FREQUENCY)									
CODE	**PRE-INTERVENTION**			**INTERVENTION**			**POST-INTERVENTION**		
TEACHER INITIATED ACTIVITIES	Lesson 1	Lesson 2	Average	Lesson 1	Lesson 2	Average	Lesson 1	Lesson 2	Average
Open ended questions	9	7	**8**	8	11	**10**	10	12	**11**
Closed questions	11	13	**12**	12	9	**11**	11	7	**9**
Probe responses	6	5	**6**	7	7	**7**	8	7	**8**
Praise responses	0	0	**0**	1	3	**2**	4	2	**3**
Challenge students' responses	1	2	**2**	2	2	**2**	2	4	**3**
Build on students' responses	6	5	**3**	3	5	**4**	3	4	**4**
Small group activity	0	0	**0**	1	1	**1**	1	1	**1**

Structured observation results (Teacher 11CF, School C)

TEACHER OBSERVATION SCHEDULE (SECTION 2: Other areas for observation)

3	2	1
GOOD	AVERAGE	NEEDS IMPROVEMENT

DESCRIPTION	PRE INTERVENTION						INTERVENTION						POST INTERVENTION					
	LESSON 1			LESSON 2			LESSON 1			LESSON 2			LESSON 1			LESSON 2		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Use of materials	*				*				*		*			*			*	
Introduction	*				*			*				*		*				*
Conclusion/summary	*			*					*		*			*			*	
Transfer of learning (bridging)	*			*				*			*			*			*	
Use of realistic examples	*				*				*			*			*			*
Distribution of questions among class			*			*			*			*			*			*
Task explanation			*			*		*			*				*		*	
Diverse problem-solving strategies		*		*				*				*	*				*	

Descriptive results (Teacher 11CF, School C)

BACKGROUND INFORMATION

Teacher Code:	**8MF**	School Code:	**M**
Class level (s):	**Form 2**	Subject (s) taught:	**Mathematics**
Experience:	**2 Years**	Position at School:	**Classroom Teacher**

TRANSCRIPTIONS OF INTERVIEW (PRE-INTERVENTION EXPERIENCES)

Q: How do you think Mathematics should be taught and learnt?

A: *I think that Maths should be hands-on. The classroom should be a learning environment and students should enjoy doing the subject. The problem is that is not always possible when you have limited materials and time to make the classroom stimulating. [long pause] further we move from class to class and there is no class that remains say a Mathematics room or something where you can have all your displays.*

Q: How would you describe your mathematics lessons?

A: *Well, I try to get students involved so I try to use, am problems and activities that relate to the subject; a bit of helping them to discover certain things. [pause] sometimes when they go overboard, I chip in to get things on track. I use the text to give exercises. After I introduce the concept, I use the text to give a chance for practice or to reinforce a concept or for evaluation of the lesson.*

Q: So what method would you consider as ideal (or best)?

A: *Well, that is difficult to answer. I would have to complete my training in other methods then be allowed to use them and see how well they work and then I can answer that. At [pause] the moment, I just started some formal training and I hope that after that I will be able to decide which works best for the class.*

Q: How do you cater for students with different abilities in your normal lesson?

A: *Well, I would give a general problem to the entire class and move around to see those who didn't understand and give them individual assistance while the others are working.*

Q: What are your impressions on small-group activities?

A: *For the younger students, that is not a good idea because you have to give constant supervision and it's like every time you have to actually put yourself in one group to supervise them, and the students, the co-ed thing. Although they have been to co-ed schools it is like they are not adapted to that yet, so for them it doesn't work because you cannot just put boys and girls in a group. If you put kids with their sex, they are too energetic; they won't settle down. If they have an activity to do together as a group, they won't co-operate because when you are correcting papers, everybody in the group has something different.*

Q: What are your impressions on whole class teaching?

A: *Whole class teaching does not work all the time but it is the best in terms of efficiency as far as I know. The teacher can plan better when you use this approach because he or she know what he or she is going to teach and exactly how long it will take so the teacher can move quickly to the next topic. I don't see what's wrong with whole class teaching. [pause] for several decades it has been the way that people learn at schools. I mean I learnt that way and I am a teacher now so there must be some good in it.*

Q: With which of the methods that we just discussed are you most comfortable?

A: *At the moment I feel better with whole class teaching. You see I don't have much experience in the other methods and people naturally do what they are more comfortable in doing. Someone may tell me that this is the way you prepare a lesson plan to teach other strategies and ask me to challenge students but if I don't know how to do it in practice then this is a problem. So training is a major factor there, don't you think?*

Q: Do you believe that students are sufficiently challenged in your Mathematics classroom?

A: *Well I would say a good percentage of the children are not motivated to even attempt a Maths question so they will not even challenge themselves to try. You put negative 12 plus anything on the board. First thing they see negative 12 and they say they cannot do that. They don't want to try. They will not draw a number line, they will not do anything – they just can't do that!*

Q: Do you think your Maths teaching improves with practice?

A: *There seems to be a slight improvement in knowing what you do with certain topics. You experiment with certain topics, especially if students did not get it in the past. [pause] but generally, I teach how I can.*

Q: Tell me about the occasions (if any) where you take opportunities to sit back and think of the successes or limitations of past lessons.

A: *Well, I do that at times but not often. I will think of how well I teach when someone begins talking about his or her teaching. [pause] that makes you think of yourself and how good a job you are doing.*

Q: How do you make use of opportunities (if any) where you might be able to share classroom experiences and teaching strategies with your colleagues?

A: *We do that, yes. We talk about everything from students to parents. We discuss students who do well in exams and those who are hopeless. It is a small school so we know them all (smile).*

Q: How would you characterise students' classroom behaviour in terms of their level of interaction?

A: *They talk a lot in class and you have to keep them quiet all the time. They will not necessarily talk when you ask them to [pause] but they will do that secretly with their friends.*

Q: What about the length and quality of responses to questions?

A: *Well, that will depend on the individual child. Some of them will give you some good answers but some others will not even attempt a response.*

Q: What do you think of their ability to think about the contents of the lesson?

A: *Again, that will depend on the class that you are in and the individual students. Even sometimes you expect a student to reason at a certain level and he or she is just below standard at the time. [pause] guess that they have their good and bad days.*

Q: How about their ability to challenge others responses to questions?

A: *They hardly do that. You have to challenge them as the teacher because the kids will not challenge each other.*

Q: What are your impressions on the number of questions asked during lessons?

A: *They ask the routine questions but nothing more. I mean some kids will ask you a good question from the blue sometimes but generally its mainly basic questions that they ask. Questions about their exercises and things like that.*

REFLECTIONS ON LESSONS:

General Comments:

Form 2 classes are weak in Maths, particularly in the areas of comprehension and problem solving. They are not as bad in computation but also have problems in terms of retention and their ability to transfer knowledge. The average class size is 28 and the students are mainly mixed in ability.

Thinking Lesson 1

The delivery of this lesson was particularly challenging. Firstly, I was not as familiar with the method of delivery as I would have liked. Secondly, since students were not used to this approach they had some problems both in understanding the activity sheets and during group work. This made delivery more time consuming than anticipated and as such the lesson was not completed. The huge class size also added to the problems with delivery since students could not move around to get into groups. The use of open-ended questions was problematic since students are weak in reasoning skills. Students were somewhat interested in the activities but began getting frustrated with the more challenging activity sheets.

Thinking Lesson 2

During this lesson, it was felt that the problems of the past lessons would be avoided. Some of the problems were and as such there was greater familiarity with the contents and structure of the lesson. However group work still remained a problem since students were reluctant to work with some members of their group. The quantity of activity sheets also appeared problematic as some students felt that they were doing the same thing over and over. As such they were allowed to do only certain portions of some of the activity sheets. The lesson was completed within the time allocated but group presentations were somewhat superficial. Student interest was maintained towards the first part of the lesson but then they began getting a bit restless towards the end.

Thinking Lesson 3

For this lesson, the plan was thoroughly revised and the necessary teaching materials were obtained. The lesson was a bit better than the previous lessons of this nature but there were still some areas of weakness. There was not as much control of the direction and pace of the lesson and as a result students deviated extensively from the topic. Efforts to get them beck on track took some time and as a result the intended presentations could not have been made. Because of the temporary loss of focus, it meant that the relevant knowledge and skills could not have been imparted to the satisfaction of the teacher. Students appeared to enjoy the lesson but the level of control and efficiency in delivery was severely affected.

Thinking Lesson 4

This lesson was satisfactory. There were still problems with group activities but this did not severely affect delivery. The method of delivery was good in the sense that it enabled all students to have some contribution irrespective of their ability level. One major concern was the class size. Since the class is rather large, it means that there is often not enough space for groups to work without distraction from others. The fact that the lessons are time consuming also means that many of the topics to be covered within the syllabus missed. Increased time spent on one topic is often at the expense of other topics to be covered. It was good that students appeared to like the format of these lessons because they are practical and they feel more involved.

Thinking Lesson 5

The lesson delivery was not as good as expected. Students were somewhat restless and did not participate fully. They had some problems in understanding the instructions on the activity sheets and some were already on the wrong track by the time the teachers went around to check their progress. This meant that the activity had to be halted to clarify the procedures. Students eventually understood the instructions but this meant that valuable time for delivery was lost. As a result the lesson was not completed within the time period.

Thinking Lesson 6

This lesson took much teacher preparation and familiarity. It appeared to be beyond the scope of students since they did not have the prerequisite knowledge. As such the lesson had to be modified to suit their ability level. Students appeared more comfortable with the simple questions requiring straightforward answers as opposed to higher order questions. Group activities were still an issue because of class size. Group presentations were of a higher quality than in previous sessions and it appeared that students were getting used to the idea of group work. Although the lessons assist students in thinking differently, it means that the teacher has to do much more work in planning and in getting materials that are not always readily available.

Thinking Lesson 7

This lesson was successfully delivered. It was interesting and it related to real life experiences. Students had a great time in creating there own patterns. They enjoyed working together and were eager to present their work. During the lesson students were able to do as many of the problems as they could manage and that meant that all students were adequately catered for. The class discussion after group presentations was of a high standard and all students were able to benefit from the activity. The only concern was the fact that there was extensive preparation and this was time consuming considering the fact that there were other lessons to prepare for the day. This meant that this level of preparation was a good idea in theory but in the practical school setting where the teacher has several classes to teach for the day, time for preparation and access to materials might not be as simple.

Thinking Lesson 8

The lesson was not taught since the teacher was absent from school on the scheduled date.

Thinking Lesson 9

This lesson went well since students enjoyed the fact that they were allowed to discover formulas. Groups were allowed to make presentations and there were interesting variations to the established methods of solving the problems. This however meant that the prescribed formulas did not carry as much weight as was intended to. The fact that students would be expected to use such formulas during examinations meant that they had to be informed that this was the formulas of preference. The lesson went beyond the time allocated because students' discoveries took more time than anticipated.

Thinking Lesson 10

Students enjoyed the lesson but from a teacher's perspective there was not sufficient pace to ensure that the objective was achieved within the time limit. Students demonstrated an unusually high level of reasoning and there was an interesting discussion at the end of group presentations. A conscious effort was made to encourage students to respond by giving more praise to the weaker ones. This seemed to have generated a greater response rate from the class. Students appeared very relaxed in their groups but the use of group activities meant that some students within the group did most of the work while others did very little.

TRANSCRIPTIONS OF INTERVIEW (POST-INTERVENTION EXPERIENCES)

Q: How would you describe the normal Maths lessons that you did in the past year?

A: *Well my normal maths lessons are basically about telling students how to do things. That's basically how they were. They were more like instruction and demonstrations.*

Q: How would you describe the thinking lessons that you did in the past year?

A: *Well, the thinking lessons, they kind of assisted us in the multi-level thing that they want us to do in schools now. They want us to do multi-level teaching so in terms of that we can do both our normal lesson and the thinking lesson and the thinking lessons would facilitate better learning so then the students who always pick up during normal lessons would do and the thinking lessons could be more of a reinforcement of the lesson taught or something more practical because most of the thinking lessons are things that are hands-on and you can actually relate to what you are doing.*

Q: So do you think that students would benefit more from lessons that are practical?

A: *Well, I have to say that because it is the second formers that I am dealing with and they are not quite settled as yet to be in a lecture field or something like that so you must expect that once they can probably take their hands and put things together, actually seeing things formulating in front of them, it would be better for them. [pause] so for my second formers, I would say yes. But probably for the upper forms maybe the normal lecture style would be quite all right, though the thinking lessons would reinforce their work also.*

Q: Were there any changes in your beliefs on the teaching and learning of Maths?

A: *It's not really about a difference in thinking as such because everybody knows that if you can put Maths in a practical way pupils will learn better.*

Q: So you knew that?

A: *Yes, we always knew that [pause] but it's about finding the means and the materials to put it in that way and if you are not creative enough or if you don't have enough time to think about it, then you will not find it so you will just have to settle with what you know as fastest and easiest for the time.*

Q: Were there any changes in your practice on the teaching of Maths?

A: *I would say with the lessons I did, I tried to change my approach and some of them went well. Some were also unsuccessful and I think that is because the system is not ready for that approach. [pause] they want you to finish a syllabus before exams and then you have to rush everything. [pause] and the classes are so large and every single student is different in terms of his or her capabilities so it is not as easy to adopt these approaches.*

Q: Were there any changes in the way that you catered for students with diverse abilities?

A: *Well, no, not really. I would still use the same approach as I used to but at times would allow those who are more advanced to assist the weaker ones.*

Q: Were there any changes in your beliefs on whole-class teaching?

A: *I think that students should learn in ways that they are most comfortable. There are some who can cope well with the whole group thing but there are others who can't. [pause] I mean in the ideal setting where students are taught in the way that they learn best but we cannot do that here so we have to teach all of them together. The education system has to change if we want to make any progress with teaching. [long pause] firstly, all teachers need to be trained as soon as possible an more money has to be pumped into the physical structure of schools if we want to make a real difference.*

Q: Were there any changes in your beliefs on small group activities?

A: *Small group activities can work but it takes time, patience, materials and expertise. We hardly have any of these here now. Well, the only one we probably have is patience (smile). Students seem to like the idea but you really have to force it considering the limitations of space and time constraints. [pause] I means in the average term we have to give students extra classes after regular school hours just to keep up with the syllabus so you can imagine how far behind we would be if we had to engage in group work and things like that all the time.*

Q: Which of the strategies discussed did you use most often in the past year?

A: *I used whole class teaching most because for me that's what works best in this system that we are stuck with. [long pause] there is only so much that you can do as a teacher, and you just do what you think is best based on what you have at the moment. I mean you will try to kill yourself to ensure that the students do something good and no one recognises your contribution, not even the school does at times. People always give you your flowers when you die. If there are any for me I would like mine while I am still alive.*

Q: What are your opinions on reflective teaching?

A: *I try to do that at times, but then again the time factor comes in there also. I mean you will never be able to check on your performance if you don't reflect. You may think that you are doing a good job but when you really think it over, it may not be as good as you may have originally thought.*

Q: How do these relate to your opinions a year ago?

A: *Well, I probably do that more now than a year ago. I think that it takes a lot of time to do it formally but I guess that if it helps the teacher to improve then at the end it's worth it.*

Q: Were there any changes in the level of collaboration among your colleagues during the year?

A: *We always talked. I mean there are not many of us here so we have no choice but to work together. We did that more formally in the past year but we have always been communicating.*

Q: How would you characterise students' classroom behaviour during your Maths lessons in the past year, in terms of their level of interaction?

A: *They talked more but at the same time it was more difficult to keep them focussed. [pause] I think that class discussion was of a higher level on most occasions.*

Q: What do you think of the length and quality of their responses to questions?

A: *I think that some students were quite good at answering but others could not be bothered. It is always like that, I guess. [pause] some students are excited while others don't care. Some contribute quite a bit and always want to be called upon while others hide behind their peers to avoid being called upon. [long pause] you find some think a lot, while some hardly ever use their minds. I guess that's what makes the diversity in classrooms.*

Q: Do you think that they were able to challenge others responses to questions?

A: *In most instances they will support the answer given just so that they don't have to think of their own response. [pause] guess that to them that is the safest way.*

Q: What are your impressions on the number of questions asked during lessons?

A: *Students did not ask more than usual. Well, the brighter ones would ask some challenging questions at times.*

BACKGROUND INFORMATION

Teacher Code:	**11CF**	School Code:	**C**
Class level (s):	**Form 5**	Subject (s) taught:	**Mathematics**
Experience:	**10 years**	Position at School:	**Head of Department**

TRANSCRIPTIONS OF INTERVIEW (PRE-INTERVENTION EXPERIENCES)

Q: How do you think Mathematics should be taught and learnt?

A: *I think that Maths should be action oriented. Students must do things and try to remember the methods or formulas to solve problems. I also think that practice is important in learning Mathematics. The Mathematics classroom should be like a little laboratory where students discover things and feel a sense of belonging.*

Q: How would you describe your Mathematics lessons?

A: *They are mainly explaining. I mean, I introduce the topic, explain formulas, give examples, then ask a few students to come up to the board to try them and then give further exercises so that all can practice. Sometimes I allow them to work in groups or work on their own and try to discover things for themselves but they take so much time doing so that at times you have to just tell them and hope that they will remember.*

Q: So would you consider this the ideal method?

A: *Well, I don't know if it is the ideal. [pause] I would not say so really, but I think that it works because at the end of the lesson some students appear to understand the work, although some have problems remembering later in the term. [long pause] The thing is because we have so little resources and time, there is not much else that we can do.*

Q: Besides the approach that you just mentioned, what other approaches do you use?

A: *I use some discovery learning on occasions but not very often because it is too time consuming. Other than that it is pretty much when I explained earlier.*

Q: **How do you cater for students with different abilities in your normal lesson?**

A: *At times, I work with the slower ones while the other students are doing their work. On other occasions I ask them to see me after the lesson but then I rarely have time for that because I have other classes to teach. When we have afternoon sessions, I have more time so I work with the slower ones then.*

Q: **What are your impressions on small-group activities?**

A: *I think that this is not so much of a good strategy particularly when it comes to seeing what students are capable of doing because when students are working together, you don't know what they are able to do individually. [long pause] The idea is good in theory but it only works in practice in a context where the teacher has a limited number of students, lots of space and lots of support.*

Q: **What are your impressions on whole class teaching?**

A: *I think that whole class activity is a good way to tell who is learning and who is not. It also gives the teacher some direction in terms of what to teach and how fast to move with the lesson.*

Q: **With which of the methods that we just discussed are you most comfortable?**

A: *I am most comfortable with whole class direct instruction. I mean I know about other strategies but the direct instruction approach seems to work for me in the current context.*

Q: **Do you believe that students are sufficiently challenged in your Mathematics classroom?**

A: *Yes, I think that the work is difficult enough. I mean if you look at students' exam results you will see that they barely able to make it. They always complain that Mathematics is hard, even when they enter secondary school they come with a hatred for Mathematics. It seems that something goes wrong somewhere even before they come to us.*

Q: **Do you think your Maths teaching improves with practice?**

A: *Yes, I feel that I am getting better in dealing with students. After you have been through all their techniques after so many years, you sort of know it all and there is hardly any way that they can trick you. [long pause] In terms of methods, I am always open to trying new methods. As long as they are not too much work for the teacher and they show results, then I may stick with them. In terms of contents I try to keep abreast with information. Sometimes you have only little time to do so, but I try to.*

Q: Tell me about the occasions (if any) where you take opportunities to sit back and think of the successes or limitations of past lessons.

A: *I learn from my mistakes. I don't consciously think about them but I have them at the back of my mind. I try to capitalise on my successes and that's my inspiration.*

Q: How do you make use of opportunities (if any) where you might be able to share classroom experiences and teaching strategies with your colleagues?

A: *We discuss what happens in the classroom in terms of student learning including good or bad test results. We also share teaching materials when we can because you know what the situation is like in terms of lack of teaching resources.*

Q: How would you characterise students' classroom behaviour in terms of their level of interaction?

A: *They contribute at times but it depends on the type of lesson. If it is something that they love doing, then you will get more from them in terms of their contributions. When they are enjoying a lesson it can easily be noticed because you as the teacher can see the enthusiasm in them*

Q: What about the length and quality of responses to questions?

A: *Most of their answers are rather short. They will provide in-depth responses only when you really get at them and keep probing. I think that it depends on the question that you ask. If you ask a question where they know that they can give their own ideas, then they will give you a longer answer.*

Q: What do you think of their ability to think about the contents of the lesson?

A: *They at times provide really absurd answers. I mean at times they will really give you good stuff but at other times they are so far from what you want to get from them.*

Q: How about their ability to challenge others responses to questions?

A: *They agree with whatever is said just to avoid expressing their viewpoints. I mean, they would say more if you probe further, like if you ask whether they really agree, then they might sense that something might be wrong with the response and change their minds, but they rarely give you reasons for their trend of thought.*

Q: What are your impressions on the number of questions asked during lessons?

A: *Well, they always ask questions in my class. I try to make them see that it is a good thing to question others.*

REFLECTIONS ON LESSONS:

General Comments:

The average class size is 26. Students are for the most part homogeneous and are generally high achievers. However, the main constraint to effective learning is the limited time available to cover an extensive syllabus. Another hindrance is the many misconceptions that the students possess, particularly in the area of algebra.

Lesson 1

The delivery did not go exactly as planned. Initially, group work was a problem since some students were reluctant to work with others. Students had participated in groups before but it was not something that they did very frequently. This means that I had to take some time to discuss how people work together in groups and on consideration for others. This took most of the remainder of the session and as such much more could not be achieved.

Lesson 2

Planning for this lesson was difficult and time consuming but the lesson went better than the first. Students had some problems in understanding some of the activity sheets and that required additional explanation. Students appeared a bit more relaxed when working with others so it seems that the talk that we had the day before had worked. Their presentations were satisfactory but it seems at times there was competition within groups in terms of who would get the correct answer first. This was not too surprising because the students always competed among themselves. From a teacher's perspective, the lesson was a challenge and a learning experience since many new perspectives were discovered from the presentations made by students.

Lesson 3

The lesson was not completed due to alternative school activities.

Lesson 4

This lesson was successfully delivered. I was able to use a circular chart, which I created, to teach all three trigonometric ratios-sine, cosine and tangent looking at all angles from o to 360 degrees. I am certain that this activity was significant in enhancing students' understanding of trigonometric ratios. Normally, it would have taken to week to do that topic. However, I was able to teach all three ratios in one week. Furthermore, students' understanding was more profound.

Lesson 5

The use of thinking lessons has meant a slight change in my teaching approach. I now spend more time on probing students' responses and attempt to ask more challenging questions. I have also realised that I make greater use of praise in the classroom and students seem to be responding but an increase in volunteered responses. Some students still have problems in volunteering responses to challenging questions. The lesson was not completed within the time frame because many groups were not able to complete the activities on time.

Lesson 6

The lesson was not taught due to an extended morning assembly

Lesson 7

The lesson was satisfactorily delivered. Some students still appeared to have problems with working together in groups. The time consuming nature of the lesson meant that it was difficult to ensure completion within the expected time frame. It was observed that students grew in terms of the responses that they gave to questions. Student responses showed a greater level of thoughtfulness. Group presentations were also of a higher standard. Thinking lessons appear to be much noisier than normal lessons but it seems that students are actually engaged in some meaningful activity. From a teacher's perspective it is difficult to assess real learning on an individual basis because it seems that time often runs out before individual exercises can be completed.

Lesson 8

The lesson was successful. Most students got a chance to contribute. The topic was interesting and one in which the teacher shared a great enthusiasm. Students were challenged some of the activity sheets and it was clear that they showed a greater level of thinking. The activities were practical and it was evident that students were enjoying the group activity. There was less of a noise problem than in the previous lesson and students appeared to have finished their group work within the specified period.

Lesson 9

This lesson could not have been completed within the time frame because there was only a 35-minute period to complete the lesson because of house meetings. Since such a lesson requires a double period, it was put off for the next double session.

Lesson 10

This was a well-executed lesson and students appeared to have a clear knowledge of activities during previous lessons of that nature. The introduction was interesting and that maintained students' interest throughout the lesson. Some of the activity sheets were rather repetitive and therefore students were asked to complete only portions of the note sheets. There seemed to be a higher level of discussion since students were actively in disagreement with the responses of others. The success of this lesson was also attributed to the level of consultation that I had with other staff members based on their experiences on that topic.

Q: How would you describe the normal Mathematic lessons that you did in the past two terms?

A: *Well, as expected it was generally talk and chalk excepting areas where we have aids, which are very few. I would mainly teach them in whole group when I have to introduce a topic. Sometimes if I have to go deeper into the topic I would use small groups but the major way of teaching is whole group.*

Q: How would you describe the thinking lessons that you did in the past two terms?

A: *I think that they were a challenge but not particularly intimidating. They helped students in that they could see the relevance of Maths, although they took too much time.*

Q: What do you mean?

A: *Well, you see, I think that senior teachers, competent teachers like myself would have no problem in trying out something new and challenging but for the newer ones, who just came from college, they would have more problems. [pause] You see, the younger teachers are fixed in one way of teaching and that is using the textbooks to teach and they would find difficulty in changing the approach because that was what was done in their college years. It is like a thinking child in the classroom is a threat to such teachers because if that child takes the discussion out of the box, then you understand the problem there? [pause] It makes other children uncomfortable also because they feel like the teacher doesn't know what he or she is about. [long pause] So I think the problem is not really about whether the teacher is comfortable but I think that most of the teachers that we have are from six form college and it takes a while before they are formally trained and it certainly is a challenge for them.*

Q: So, are you saying that the less experienced teachers would be more reluctant in adopting the approach than the more experienced teachers?

A: *Certainly, because the students come with the notion that the person who is in charge must be competent and must know it all and they give more respect to experienced teachers since they think that younger teachers may have inadequate knowledge. Now students are coming into the classroom with great expectations and young, untrained teachers are coming into the classroom very nervous. They only remember the bare content of what has to be taught and when they have to teach a thinking lesson, a thinking child might carry the discussion further. Now when the teacher is unsure the other students in the class would lose confidence.*

Q: Wouldn't that require the experienced teachers to keep abreast with information to a great degree?

A: *Erm, not the person's knowledge base. [pause] Information is rapidly changing and kids may go on the Internet for new stuff and bring it to the classroom and you don't know what it is all about but with experienced teachers, their experience will allow them to tell the kids, let me see that? [long pause] The teacher may ask the student where did you get that? And the teacher will then say, let me go to check on that too. So the child does not feel like you are saying no. She will feel like everyone is learning together, so I really don't see experienced teachers as being uncomfortable. These teachers understand that some children are even brighter than the teacher. [long pause] It will take you the teacher ten minutes to get a concept and some of the kids take a minute and they are watching the teacher, you know? So after years of seeing that as an experienced teacher, you lose the notion that you are in charge.*

Q: It was interesting that you looked at it in this manner because many theories suggest that experience breeds resistance to change.

A: *Well, that's a personality issue and should not be considered a generalisation. It all depends on the individual and may not necessarily be linked to experience. [pause] With experience you learn to listen to others views, put forward your own, look at the similarities and differences between them and see where you can agree. I don't believe experience teachers resist change. I think that experience brings flexibility. [long pause] It brings strength and it brings openness. It is not threatening. You know that you have confidence and you see the child not as inferior person but someone who come to the classroom with something useful. [pause] Once we have recognised this, we respect the students. As an experienced teacher, you understand the saying that your own child will teach you.*

Q: Were there any changes in your beliefs on the teaching and learning of Mathematics?

A: *I believe that lessons like the thinking lessons are good. They are much better than the traditional lessons but even in the lower secondary school that is too late. [long pause] From early in the primary school students have the culture that miss say so and discussion is non-existent. [pause] whether the item is right or wrong, that is what miss says.*

Q: Were there any changes in your practice on the teaching of Mathematics?

A: *Well, sort of. I tried to consciously reflect on what I do. The journals also helped in that regard. I also tried to make greater use of other approaches. One area that I was conscious of way what I do in the classroom in terms of how I handle the different*

components of the lesson. I was also more aware of encouraging students by praising them and the ways in which I posed my questions to them.

Q: Were there any changes in the way that you catered for students with diverse abilities?

A: *I try to work with them individually but sometimes, they feel uncomfortable because of the fact that the other students know of their underperformance. [Long pause] it is like everyone knows why I am with that student so I try not to make it too obvious*

Q: Were there any changes in your beliefs on whole-class teaching?

A: *Well, I now think that whole class teaching is probably better for the teacher than for the students. [long pause] It makes life easy for the teacher in terms of the direction of the lesson and in terms of how much you can cover for the term and also in terms of dealing with behaviour. But I don't think that the student really gets much in the long run. Still don't know why we do it though. That should not be but I guess that everyone wants to make life easier.*

Q: Were there any changes in your beliefs on small group activities?

A: *Well, erm [pause] I think that it has proven fruitful. I mean, its not every time that you expect you can use small groups because you have to think of the time constraints but on occasions when I did it, it turned out alright and I think that the students enjoyed it also.*

Q: Were there any changes in your beliefs on lessons that challenge students to provide diverse responses?

A: *That should not be a question, the answer is automatic. [pause] you should know the response [long pause] of course you should challenge students. If you don't challenge them, then how are they going to broader their minds?*

Q: So, do you think that your students were sufficiently challenged?

A: *Well [pause] considering right now, due to the [pause] erm the new entrance into high school scheme that is being piloted, I mean the Universal Secondary Education. [pause] Due to that, we get all sorts of students and there are those that can hardly even read so, the normal lesson is ample challenge for them. But at the same time you have to consider those students who did well so the normal lesson challenges both groups adequately. However, I mean, I see the thinking one as bringing more imagination.*

Q: What are your opinions on reflective teaching?

A: *I think that the teacher has to reflect because it helps you see if you are doing the job that you are paid to do. Even if you don't write down your reflections, it is still useful to reflect. When you write on a report book the child cannot add, [pause] you are actually indirectly writing, I did not teach the child to add. At the end of the year, the teacher may discover that out of a class of thirty, twenty cannot do the work. You may not be able to help them at this point, you know that at the end of the year you have another class coming up, [pause] and even in the same class some of the students might repeat so you have another chance to help them. That is also reflection on your performance in the classroom.*

Q: How do these relate to your opinions a year ago?

A: *I always regarded reflection as worthwhile but probably did not appreciate its significance. Guess that it has to do with the other things that you give priority in your teaching.*

Q: Were there any changes in the level of collaboration among your colleagues during the year?

A: *We often communicated but having something to talk about as the thinking lessons made collaboration even more worthwhile and essential. [long pause] We had something definite to reflect upon. The programme was like a catalyst to real reflection.*

Q: How would you characterise students' classroom behaviour in terms of their level of interaction?

A: *Children will be active if you give them exercises and practical things that they can do. If you are trying to explain and you talking and demonstrating, the students are just looking at you,[pause] like what are you saying?*

Q: What do you think of the length and quality of their responses to questions?

A: *I would say that the thinking lessons caused students to think more and to understand with a deeper appreciation and a broader perspective. Their answers reflected a higher level of thinking to some extent. They also appeared to take their learning a bit more seriously.*

Q: What do of think of their contribution during lessons?

A: *I think that some students are naturally eager to respond while others are not. It depends on their personality. [pause] That does not mean that those who don't want to respond are not aware of the correct answers. It is just that they are shy. When you ask them,*

they give you the correct answer but some students just will not volunteer responses no matter what you try in the classroom.

Q: How about their ability to think about the contents of the lesson?

A: *Well, I would say that there are good thinkers and there are those who daydream. The group presentations showed some level of thought. [long pause] I would say that collectively, students always show some awareness of the contents being discussed but individually the level of thought varies.*

Q: Do you think that they were able to challenge others responses to questions?

A: *It depends on the lesson. During group discussion they would do that on occasions. However, the teacher would have to set the scene for them to do that. I think that you have to get it out of them by the questions that you ask. [pause] For instance you can ask; is there anyone in Group B who does not agree with the opinion of Group A? The students may then want to voice their opinions on occasions.*

Q: What are your impressions on the number of questions asked during lessons?

A: *I have always encouraged my students to ask questions so I find that they generally do ask a lot of questions. I try to make them see that asking questions is a quality of intelligent students so they ask questions to prove to me that they are intelligent (laugh).*